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Contents

In This Issue

The poet Annie Dillard wrote that "Symbol does not only refer, it acts. There is no such thing as a *mere* symbol.... In the last analysis, symbols and art objects do not stand for things; they manifest them, in their fullness" (*Living by Fiction*). Through its symbols—words, numbers, figures, and mathematics—economics proclaims its own reality. An economy described and explained exists in its own right without dependence on some worldly composition of land, labor, and capital. The reality of symbol insists that what economists do becomes (manifests) what economies are.

In this issue are an essay, three articles, and five reviews. Each of the articles and reviews is an element of a real world of agricultural economics, not merely fictions or representations of some more tangible economies. The Edwards essay collects these elements and describes the collection as another reality called "doing agricultural economics."

Edwards views research as three processes—describing, explaining, and prescribing. In his essay, he invokes these three processes to comment on theory, data, and problem specification in agricultural economics. Not everyone's research reality would include prescription as a necessary process of research, but then he also tells us that not everyone does the same thing. We specialize. Therefore, the role of research management, as in production of any kind, is critical.

Ruppel, Fuller, and McKnight examine the importance of information in contract negotiation by employing an experimental economics approach. They applied the experimental method to grain shipper contracting in the Great Plains under three levels of information. Their findings, like similar studies by other researchers, were mixed. They do suggest that increased disclosure is not always and everywhere a force for greater efficiency and lower price. The article contains extensive appendices on procedures and methods.

Covey and Babula inquire about the relationship between agricultural interest rates and expected inflation. Specifically, they employ co-integration and vector autoregression (VAR) to test Fisher's theory that nominal interest rates have a built-in factor for expected inflation rates, and to account for other, offsetting effects of inflation on expected real rates. Econometrically inclined readers will want to follow the authors' choice of VAR models over vector error correction models. Others may simply note that interest rates are positively responsive to the shock of an inflation expectation but that nominal rates rose by only 66 percent of the expected inflation.

Hahn portrays meat markets as endogenous switching models. The structural relations between farm, wholesale, and retail prices of pork and beef were represented as reduced-form equations that permit measurement of symmetry in market ups and downs. In all the variations of the models, prices in meat marketing are more sensitive to price increases than price decreases. The effect is greatest at the retail level.

Book reviews open with Goodloe justifiably lamenting "a plethora of anthologies emanating from conferences." Goodloe, while conceding a few good chapters, is generally uncomplimentary of *Free Trade and Agricultural Diversification*, and even of its sloppy editing. Her review, as if to underscore her dismay, is followed by reviews of other conference proceedings by Stallings, Mabbs-Zeno, and Clayton. However, we end with a book by just two authors.

Stallings' review of *International Financial Markets and Agricultural Trade* is similar to Goodloe's but with a nod toward some redeeming portions. The book concentrates primarily on macroeconomics rather than on agriculture. He mentions both Officer's contribution on purchasing power parity and his survey of empirical studies. O'Mara provides a brief, clear presentation of the Australian macroeconomy.

Mabbs-Zeno characterizes the proceedings of the *1988 World Food Conference* as a collection of summary statements with little news for the specialist. The papers, in two volumes, tend to be well written, appealing mostly to the generalist. Controversy is minimal.

Clayton rates Gray's *Soviet Agriculture* as "highly informative and readable." The contents of this collection, better than average, are coordinated around the theme of reforming the enormous, ponderous agricultural economy of the Soviet Union. The rapidly growing corps of instant experts on Soviet reform should find this book useful.

Kelch finds Lindblom's "partisan mutual adjustment" to be the explanation for slow reform of agricultural policy in both the United States and the European Community, the subject of *Agricultural Policy Reform* by Moyer and Josling. The public choice perspective provides the book's analytical structure, yielding useful insights and conclusions throughout, even if the

haste in rushing to publication for GATT negotiations may have weakened the closing lessons for policymakers.

Many of our readers will recognize the perspective of *In This Issue's* opening paragraph as a particular philosophical view of existence or being. Its practical significance is not an excursion into philosophy but a suggestion for how one might read the content of the *Journal*. The reader is asked to take the essay or article for what it is (or what was composed by author, aided by editor) and eschew notions of what the reader might have written on the same subject. The old homily about walking a mile in the other person's moccasins seems to fit. With Dillard's message in mind, read the essay by Edwards, then consider the realities contained in the articles and reviews of this issue.

Gene Wunderlich

Doing Agricultural Economics

Clark Edwards

Researchers in agricultural economics seek to describe and explain certain social problems and to prescribe remedies based on available data and theory. I suggest that if you were to watch agricultural economists at work at randomly chosen times you would find them doing one of three things: describing, explaining, or prescribing. And they would be using at least one of three elements or tools: problems, data, or theory. I want to talk about the way agricultural economists describe, explain, and prescribe. In doing so, I must mention research methods, but this is not another treatise on methods.

Each of the three processes can become a specialty. Some researchers are better at one process than at others. While a complete research project involves all three, the tasks can be split and coordinated among specialists, some of whom describe or explain while others prescribe. An individual in control of the entire research process does not have much of a coordination problem beyond that of self-discipline. However, research specialization in large institutions, such as government agencies and the land grant college system, requires coordination as a key to success.

Description Relates Data to Problems

In the descriptive process, researchers arrange selected data to tell a story and illuminate a social problem. I distinguish in this article between social problems for the sake of which research is undertaken and disciplinary problems encountered by researchers along the way. A researcher may ask how much farmers earn compared with nonfarmers or what the distribution of income among farmers is. When dealing with such problems, the researchers may encounter intermediate problems to solve. These are disciplinary problems, such as what theory to apply and what statistical methods to use.

Description is done with the problem in mind more than theory. Successful description, including prediction, can result even when the describer's theories are wrong. Theory, though not necessary for description, can help in pointing the way to useful results, and can sometimes suggest changes in the description. Bonnen (*3*) illustrates what goes wrong with the research process when the descriptive phase is shortened.[1] He says agricultural economists have increasingly celebrated and rewarded theory and statistical methods while ignoring data, thus undermining their capacity to do research.

The social importance of a problem addressed by research determines the relevance of the project. Choosing a problem is a subjective process, and the selection can be made in many ways. The researcher may choose a problem, the general public may express concern, or professional politicians and administrators may select and rank problems for the agricultural economics research agenda. The researcher may select data in many ways as well, through primary or secondary sources. A research project built on faulty data or focused on an irrelevant issue will be valueless, regardless of the descriptive ability of the researcher.

Explanation Relates Theories to Data

Explanation of a social problem comes out of the interaction of data with theory. Theory relates facts and concepts. For example, the data may show a correlation of Government price supports with land values. The theory helps determine which is cause and which is effect.

We use theory to take apart the descriptive material and recombine it to see what might have been. Adam Smith illuminates this point when, after noting in his first few pages that the wealth of nations depends on the quantity of labor and the output per worker, he asks what happens when the number of workers changes (through population growth) or when the productivity of workers changes (as in the pin factory) (*13*).

Arguments over the best balance of theory and data have a long history. A resolution was sought in econometrics during the first half of this century. Some econometricians leaned toward pure theory and deduction from accepted premises; others leaned toward brute force empiricism while minimizing the role of theory. When theory failed to correspond to data, one school said the theory must be wrong, the other said the data must be wrong. Castle shows how agricultural economics literature varies in the intensity of use of theory—from highly empirical to highly theoretical (*4*).

McCloskey avoids this conflict by turning against method (*9*). Instead, he treats research as a conversation: the rhetoric of economics can be examined in the same way as the rhetoric of literature. McCloskey helps to humanize what others treat as an objective process, but he diverts us from examination of research methods.

Edwards, an economist, served on the editorial board of this Journal from 1966 to 1989 and was editor during 1976-83.

[1]Italicized numbers in parentheses cite sources listed in the References section at the end of this article.

Hausman and McPherson, on the other hand, suggest that reflection on method helps (*5*). We do not need to be diverted from a study of method, they say, because too few economists concern themselves with method already. Perhaps no one method is right, but reflection on choices among alternative methods can help us avoid the many wrong ones.

Different Explanations Use Theory Differently

Much of the discussion of method comes down to where one stands on the centuries-long argument between brute force empiricism and pure theory. No wonder we can't solve it with one more journal article, or even one more book.

Farm management researchers emphasized the empirical approach in agricultural economics just after the turn of the century. Warren (*15*) and others drew on the teachings of Pearson (*10*). Production economists, who studied the same problems that farm managers studied, but who called farms firms, emphasized theory. Heady (*6*) and others drew on Black (*2*).

One group said, "Look at the data before conjecturing about hypotheses." For example, Sherlock Holmes studied all the facts first, then formulated the only hypothesis consistent with those facts. The other group said, "Formulate your hypothesis from theory before collecting data with which to test it." It took a while to become comfortable with researchers who worked both sides, who studied data for clues and theories for hypotheses, and who let progress on either front influence actions taken on the other. Not until probability theory became the basis for econometric procedures after World War II did researchers use systematic procedures to test various plausible theories with imperfect data by using probability inference.

The argument over data and theory goes on, but in different forms now. Researchers debate on model size, the degrees of abstraction, whether to use general or partial formulations, and the proper theoretical underpinnings.

Hertel points out that it is now possible to solve large models (*7*). Now that it is possible, the question arises: is it better? Can we build better models using 25-50 years of full-time equivalent work over a 5-10 year period than one person can build in 6 months?

The answer, of course, depends on what you are trying to do. Sometimes smaller models are appropriate, sometimes larger ones. It is only since larger models became feasible that the subtleties of the argument took on more meaning. Before, the failure of large models could be attributed to lack of funds, poor administrative organization, or lack of technology. Only after several projects had surmounted these obstacles could the efficacy of the larger models be judged.

Strands of the argument between the brute force empiricists and the armchair theorists live on in the debate over specific models versus general ones. Those who favor general models say the balance leans toward abstract models that are easy to understand and to generalize into a broad range of applicability. In focusing on relationships among facts and concepts, such models develop general knowledge about how the agricultural economy works.

Some researchers lean toward models that are concrete and specific. Through a high degree of effort in capturing accuracy of details, they describe and explain the real world. Such models develop knowledge about dealing with particular problems in the agricultural economy.

When smaller models were technical necessities, researchers often preferred partial equilibrium to general equilibrium models because they could not maintain the detail needed to understand certain aspects of the agricultural economy through the whole model. There were models for pork and others for dairy, but no models for the livestock sector. Models for feed grain were isolated from models for food grain. Trying to include a livestock sector in a model that already handled the crop sector could end a research project. Some models focused on commodity markets, some on factor markets, and others on retail sales. Researchers building models that embraced the whole agricultural sector, and perhaps integrated agriculture into the whole economy, had two choices. If much empirical detail was included, the logic of the model had to be simple (as input-output models are). If the theory was complex, size could be held down by making the model abstract.

Hertel shows that computer general equilibrium models are sometimes more appropriate than the more popular partial equilibrium models because they can examine aspects assumed constant in partial models (*7*). He says computer general equilibrium models can be applied; they are not confined, as some of the literature seems to imply, to the abstract and theoretical. With recent improvements in computer hardware and software, large models using general equilibrium concepts are now easy to do. Hertel writes that computer general equilibrium is not always better than partial equilibrium, any more than theoretical models are always better than applied ones. He sets out to bridge the gap between partial and general equilibrium models.

Most modeling done by agricultural economists draws on microeconomic theory. This is true of both large and small, theoretical and applied, general equilibrium

and partial. This choice suits many problems in agricultural economics well, but it means that certain important problems cannot be addressed.

For example, aggregative microeconomic general equilibrium assumes full employment of resources. Macroeconomic theory, on the other hand, recognizes idle resources in stable equilibrium. This is why macroeconomists recognize unemployment in the labor force and idle capacity of plant and equipment, while agricultural economists (using microeconomics) consider farm labor and capital fully employed.

Researchers Judge Among Alternative Theories

The choice of theory used to examine the data and analyze the social problem affects the prescription of how to deal with the problem. There are several objective approaches to evaluation of theory, but in the end, it comes down to a subjective judgment.

Some agricultural economists want theory to represent or imitate reality. Hausman and McPherson express concern for the realism of assumptions (*5*). They warn against raising assumptions to the status of *a priori* truth. They point out that Milton Friedman touted a different and more popular view: if the theory works, use it. Getting the right answer for the wrong reasons does not satisfy Hausman and McPherson.

Other agricultural economists want theory to express a point of view. Hausman and McPherson show how the choice of microeconomic theory reflects the researcher's reliance on rationality and self-interest by firms and households. Researchers who choose macroeconomics may do so to highlight idle resources or to suggest that government intervention rather than free markets can best solve the problem. Regional economists and operation researchers are more eclectic in their choices among theories. They choose a combination from the array of possible theories that will highlight what the researcher judges to be the important elements of the problem.

Others judge theory according to how well it captures formal features of the economy. For example, Hertel shows how to specify conventional microeconomic theory to bring out the important features of taxation (*7*). Others emphasize how government price supports work, or how uncertainty about weather or exports affects domestic farm output decisions.

The usefulness of the theory used to confront the data during the explanatory phase of research can be assessed in four different ways:

- Is the model logically consistent? If the conclusions don't follow from the premises, fix the logical errors.
- Does the model conform to the facts? How high are the correlation coefficients and the t-ratios? If low, you may have to improve your data or modify your theory.
- Are the prescriptions in conformance with social values? For example, if the society uses central planning and the model assumes decentralized decisions, or if the government intervenes in some markets (as with price supports) and the model assumes perfect competition, then change the model.
- Does the model feel good to you, the researcher? Is it emotionally satisfying? If you think this last sounds funny, watch a couple of excited researchers as they struggle with two pieces of chalk and one blackboard searching for a conceptualization of a problem that feels right.

Prescription Relates Explanations to Problems

The use of analysis is an important measure of a profession's effectiveness, according to Hildreth (*8*). Prescription is the end for the sake of which research is done. Research-based prescriptions flow from the descriptive and explanatory processes, depending on the definition of the problem, on the availability of data, and on the choice of theory. A prescription recommends an alternative for action. Budget-conscious national policymakers may be advised, for example, to lower the loan rates on food and feed grains. Or, profit-maximizing dairy farmers may be advised to plant small-grain fields with pasture grasses, expand the dairy herd, and purchase feed grain rather than grow it.

Making a prescription requires that the researcher take a stand on what to do. Many research economists shy away from the precarious role of policy adviser. Even though the prescription may be based on extensive and careful description and explanation, the researcher may become identified with a particular point of view. Followers may be attracted for ideological reasons rather than for the compelling results of the research process. Opposition also may develop for ideological or political reasons.

Economics is not value free. The role of value judgments is most evident in the prescriptive process. Researchers select problems, data, and theories. Judgments suggest how best to describe, explain, and prescribe.

Thompson discusses some new mergers of economics with philosophy, and of agriculture with ethics (*14*). He shows that they come together in policy analysis, that is, in the prescriptive process. Hausman and McPherson also emphasize the normative commitments inherent in positive policy analysis (*5*).

Economists often have trouble dealing with ethical conflicts because their models say the marketplace resolves all conflicts. When environmentalists disagree with commercial agriculturists they may seek legal action. Instead, the theory used by economists says: let the markets determine who is right. When values conflict concerning alternative actions, Robbins once advocated that the task of the economist is to show the implications of each alternative without expressing a personal opinion about what is best (*11*). Even though he later reversed his opinion, his original teaching lives on (*12*).

Prescription requires communication. (So do explanation and description, and researchers prescribe methods for others to use in solving disciplinary problems.) Researchers communicate with decisionmakers and other end-users of the research product by writing about descriptions and prescriptions.

Researchers' writings on disciplinary problems are often (properly) sprinkled with jargon which may appear obtuse to the general reader. But when they write to end-users about descriptions and prescriptions, the communications should be accessible and clear to all. Agricultural economists are notoriously poor communicators on both social and disciplinary problems. The peer review process is able to turn tangled first drafts into communicative third or fourth drafts when the review process is taken seriously by the reviewers and by the reviewee. Barry finds that the publication process works well (*1*).

If an economist talked only to himself or herself while doing economics, the result would eventually become gibberish, as Keynes once noted. He said that bouncing ideas off one another helps achieve relevance and intelligibility.

Research Specialization Requires Organization and Coordination

This article partitions research into three processes: description, explanation, and prescription. The processes deal with three elements: problems, data, and theory. A complete research project uses all three processes (description, explanation, prescription) and all three elements (problems, data, theory). However, agricultural economists can specialize in performing one or another of the processes or in developing one or another of the elements or tools. Research specialization is more likely to appear in larger institutional organizations.

The difficulty of coordination compounds the problems of proficiency in the processes and training in the tools. The mission of the agency may be relevant and the data reliable so that useful descriptions can be accurate and efficient. Researchers may be well trained in economic and statistical theory and practice so that significant explanations can be found. And information specialists may be able to assure a steady flow of description and prescription to end-users. But, if the research institution is to reach its potential, problems with weak leadership, absorption of budget cuts, reorganization, and other administrative obstacles must be handled so that individual researcher initiative is not discouraged.

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Grain Shipper/Railroad Contract Disclosure: An Experimental Analysis

Fred J. Ruppel, Stephen Fuller, and Mary McKnight

Abstract. *The Staggers Rail Act (1980) permitted confidential railroad contracts. Legislation later required disclosure of certain contract terms to allay small shippers' claims of injury. This study uses experimental economics to analyze the effects of information disclosure. An oligopolistic market structure was designed to simulate the market for rail services in the South and Central Great Plains. Contract information was disclosed to test participants under three scenarios: no disclosure, partial disclosure, and full disclosure. The analysis revealed favorable impacts on efficiency but no discernible effect on negotiated prices. An unexpected outcome was profiteering by some participants under the partial disclosure format.*

Keywords. *Experimental economics, transportation, grain transportation, railroad contracting.*

The Staggers Rail Act of 1980 was one of the most dramatic changes in Federal policy toward railroads since the Interstate Commerce Act of 1887 (*3*, *10*).[1] One of the most controversial provisions of the Staggers Act (section 208) permitted railroads and grain shippers to enter into confidential contracts. These contracts typically committed grain shippers to minimum shipment sizes and volumes, with the railroads providing transportation services at below-tariff rates.

The contracting provision of the Staggers Act generated concern among some agricultural shipper groups, such as the National Grain and Feed Association, who argued that small shippers were disadvantaged by the high-volume contract rates offered to large shippers. The small shippers felt that Staggers contracting helped discriminate against them, reducing competition. In view of this concern, Congress enacted Public Law 99-509 in October 1986. Section 4051 of this law required increased disclosure of essential contract terms. Expanded disclosure presumably would reduce shipper discrimination. In December 1986, the Interstate Commerce Commission (ICC) issued interim rules (Ex Parte 387) implementing the provisions of Section 4051. These rules required additional and more specific disclosure of contract terms in general and allowed for complete disclosure when an affected shipper filed a petition for discovery of additional contract terms (*4*).[2] With these two levels of disclosure, the ICC was attempting to balance the conflicting requirements of contract confidentiality with disclosure of essential terms to potential complainants.

Some shippers oppose increased contract information. They argue that the price confidentiality feature of rail contracts has enhanced competition because railroads are prevented from knowing precisely what prices they must compete against in order to acquire traffic (*14*). The shippers are urging the ICC to limit rules that publicize the contents of railroad contracts. Recent studies have shown that deregulation under the Staggers Act led to dramatic rate reductions, particularly in the Plains States (*1*, *5*, *11*, *12*, *13*). Some shippers believe that these rate reductions were largely created by the confidentiality of rail contract price information and that the current trend toward fuller disclosure of contract terms threatens the apparent competition among railroads triggered by deregulation.

More likely, the outcome of increased contract disclosure is uncertain. One's interpretation of history and belief in certain economic assumptions will influence one's attitude to the effect of disclosure on competition. In this article, we explore the consequences of selective contract information disclosure on prices (rates) and profits of grain shippers and railroads in the Great Plains through the use of laboratory experiments designed to capture the essence of the real-world environment.

Similar issues have been analyzed in laboratory settings. Hong and Plott explored the consequences of a proposed rate publication policy for the U.S. barge industry this way (*7*). The proposed policy required a carrier to file a rate change with the ICC at least 15 days before the rate change was to become effective. Hong and Plott contrasted the proposed posted rate policy with negotiated rates and found that posting caused higher prices, lower volume, and reduced efficiency. Claims that rate-filing policies would improve market operations were not supported by the results.

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[1]Italicized numbers in parentheses cite sources listed in the References section at the end of this article.

[2]First-tier disclosure includes such items as shipper identity, origins, destinations, transit points, movement capacities (single-car, multiple-car, and unit-trains), contract duration and implementation dates, volume requirements, commodities covered, and base rates that would apply in the absence of a contract. Actual rates and charges were not to be disclosed until a petitioning shipper could show that it was ready, willing, and able to participate under the terms covered by first-tier disclosure and could show itself to be an affected party.

Research by Grether and Plott examined the possible relationship between posted prices and certain industrial practices in an oligopoly of manufacturers of lead-based gasoline additives (*6*). The Federal Trade Commission had charged that an existing price-posting policy was anticompetitive, while the manufacturers maintained that the pricing was simply the result of the highly concentrated market structure. Grether and Plott refuted the oligopolists' claim that concentration alone, unaided by certain practices, did not necessarily foster collusionlike prices. (See *16* and *18* for related studies.)

Region Background

This article centers on rail transportation for grain in the South and Central Great Plains, a region including Kansas, Oklahoma, Texas, eastern Colorado, and a portion of southern Nebraska. The area is a major producer of Hard Red Winter wheat. Railroads dominate there because the region is landlocked and must ship extended distances to reach principal markets. Over half of the wheat production in the region goes to the export market, with about 90 percent exiting via Texas ports. A 1985 survey of grain export firms operating on the Texas Gulf showed that 93 percent of their wheat receipts from this region arrived by rail (*15*).

The study region's grain-handling and assembly system is unique compared with other surplus grain-producing regions in the United States. Country elevators assemble grain from producers in all regions. But, unlike other regions, the grain is then assembled by secondary holders at transshipment locations. Fifteen major transshipment locations in the region store and condition grain until final shipment to port or to a domestic demand location. Based on the 1984 waybill data (*8*), an estimated 82 percent (454 million bu.) of rail-transported wheat receipts at Texas ports moved via these transshipment locations. The rest moved directly to port from country elevators.

The secondary holding facilities at these transshipment locations are operated by the major international traders (Cargill, Continental, Bunge, Dreyfus, and Elders), a regional cooperative (Union Equity), line elevator companies, and firms that specialize in secondary holding. Based on data published in various State trade directories, (Kansas Official Directory (*9*), for example), we estimated that 10 firms operated about two-thirds of the 85 transshipment facilities in the region. The major international traders and the regional cooperative operated all export facilities at Texas ports except those managed by two port authorities. Although market share information is not readily available for the grain shippers, the regional cooperative dominates transshipment locations in the South and Central Plains with just under half the total market. The remainder of the market is divided among three major international traders (*15*).

Ten Class I railroads operate in the region, six of which link the region with Texas ports: the Santa Fe, Burlington Northern, Union Pacific, MKT-OKTT, Kansas City Southern, and the Southern Pacific. The Kansas City Southern links Kansas City with the Port of Beaumont and has only a limited gathering system. The Southern Pacific extends between San Francisco and New Orleans, operating little trackage in the study region. The MKT-OKTT is also a relatively small carrier because of its modest gathering system. Based on the 1984 railroad waybill data, the other three carriers (the Santa Fe, Burlington Northern, and Union Pacific) assembled nearly 90 percent of all export grain to Texas ports.

A collaborative project between the U.S. Department of Agriculture and the ICC provided important information on the provisions and role of contracts between study region shippers and railroads (*11*). The project, which studied all contracts written between grain shippers and rail carriers in Kansas during 1980-83, reported that contracts typically included only the largest grain shippers (the international traders, the regional companies, and large regional cooperatives) who were offered rate reduction incentives by the carriers based on shipment size and volume. Almost no contracts were consummated between country elevators and rail carriers. About 75 percent of the contracts involved movement between the region's transshipment centers and port facilities via contract rates rather than by tariff schedules.

Contracting between grain shippers and railroads in the study region was characterized by an oligopolistic market structure with only a few large grain firms contracting with the region's several railroads. Our experimental approach represents this market structure.

Methods

The experiment was designed to test the impact of selective information disclosure on trading prices and on buyer (grain shipper) and seller (rail carrier) profits. An experimental economic environment was created to reflect the market for South and Central Plains rail services, with downward sloping resale values schedules for the buyers and upward sloping costs of production schedules for the sellers. We characterized the existing market structure (Union Equity, Cargill, Continental, Burlington Northern, Santa Fe, and Union Pacific) with one large buyer (LB) and one large seller (LS), each of whom controlled half of their respective markets, and two smaller buyers and sellers (SB1, SB2, SS1, and SS2), each with a one-quarter market share. Six student volunteers were randomly assigned buyer or seller trading status in each of the twelve 2-hour experimental sessions.

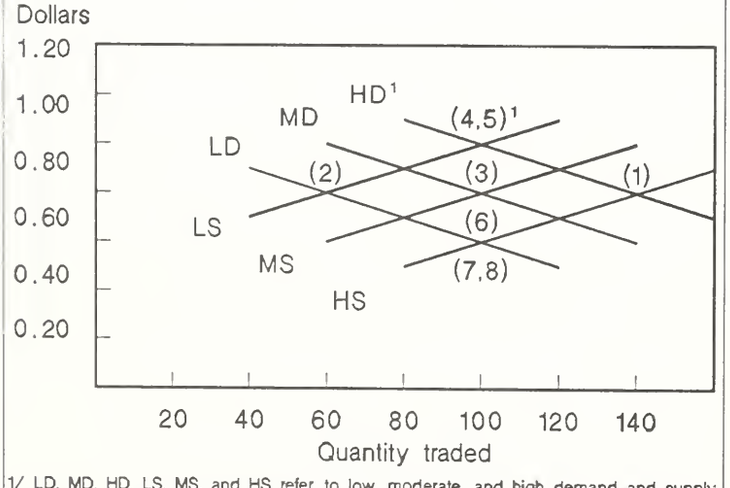
Three sets of market demand and supply schedules (reflecting low, moderate, and high demand/supply conditions) generated nine possible equilibrium points. Appendix A shows sample schedules reflecting low demand and high supply. The demand/supply conditions varied by period (fig. 1). Training period 1 reflected high demand/high supply (HDHS) conditions. Training period 2 reflected low demand/low supply (LDLS) conditions. Periods 3 and 6 were transition periods with moderate demand and moderate supply (MDMS). Periods 1, 2, 3, and 6 had equilibrium prices of 80 cents throughout, and equilibrium market quantities of 140, 60, 100, and 100, respectively. Periods 4 and 7 were baseline periods, and were either high demand/low supply (HDLS) or low demand/high supply (LDHS) equilibria. If period 4 was HDLS, then period 7 was LDHS, and vice versa. Periods 5 and 8 were disclosure periods, and had the same equilibria as the preceding period. The baseline and disclosure periods had equilibrium prices of $1 and 60 cents for HDLS and LDHS, respectively, and equilibrium quantities of 100 throughout. Absolute values of the slopes of the schedules were identical between buyers and sellers, with the slopes for the smaller traders twice as steep as for the large traders.

At the end of each session, the subjects were paid prearranged fixed percentages of the sum of their six trading period profits for the evening, with the percentages set such that the expected payout of $18 was identical for each market participant. No prior information was given to participants about minimum payout amounts, but when earnings were low, subjects were paid a minimum of $10 per session. The highest payout for an individual participant was $27. Over all 12 sessions, the total payout amounted to 97.4 percent of the expected payout.

The 12 sessions were equally divided along a 2×3 treatment design (fig. 2), reflecting a high or low price in periods 4 and 5, and one of three information disclosure treatments: none (NO), partial (PT), and full (FL). Under the no disclosure treatment, there was no information on previously traded quantities or prices made available to the traders. Under FL, prior to trading in periods 5 and 8, all participants received a listing of all trades contracted during the prior trading period. Under PT, following periods 4 and 7, traders were allowed to request information on two trades from the prior period. Each of these requests specified (1) a particular buyer or seller involved in a trade, and (2) a particular piece of information on the trade: either the first trade, the last trade, the largest quantity traded, the smallest quantity traded, the highest contract price, or the lowest contract price associated with the trader specified. There were two experimental sessions for each cell in figure 2.

The subjects received their instructions (see app. B) and were placed in separate offices on one floor in the department of agricultural economics at Texas A&M University, with two phone lines available to each trader. Following two 15-minute training periods, six 10-minute trading periods were run. The training periods familiarized the subjects with the trading environment and determined whether they understood the nature of their supply/demand schedules. The trading price was fixed during the first training period with the subjects allowed to conduct as many trades and to transact as many units as they desired. A maximum number of units to be traded was imposed during the second training period with prices negotiable, again to test their understanding of the schedules and to provide practice in bargaining with one another.

Figure 1
Supply and demand possibilities



1/ LD, MD, HD, LS, MS, and HS refer to low, moderate, and high demand and supply.
2/ Numbers in parentheses refer to experimental periods.

Figure 2
Sessions by treatment

		Disclosure		
		None	Partial	Full
Price	High demand, low supply	3,11	2,12	5,10
	Low demand, high supply	4,7	1,8	6,9

Beginning with the third period (the first nontraining period), the subjects could negotiate a maximum of three trades, up to one trade each with each participant on the other side of the market. In pilot runs, a tendency had been observed for second and third trades between identical subjects at "distorted" prices or involving only a few units traded. The intent behind placing the limitation on the number of trades was to diminish the likelihood of these "meaningless" transactions.

Results

Plott and Smiths' methods helped establish a perfectly efficient market standard to measure overall trader efficiency. This standard assigned period-specific equilibrium prices to all trades and optimal quantities to all traders. Given the inframarginal nature of the last unit, this perfectly efficient solution (PES) was 97 units traded per session (24 units for each of the smaller traders and 49 units for the larger traders). The mean of the actual units traded over all 12 sessions was 90.1 units per period, which amounted to 92.9 percent of the efficient solution. Overall profits were somewhat higher, at 94.2 percent of the standard. Efficient trading of 90 units per session would have resulted in 99 percent of PES profits. Actual profits were diminished when traders either failed to trade their allocation or exceeded it, both individually and as a group. Individual traders recorded either zero or negative profits in only four periods.

Summary Results for all Trading Periods

Buyer and seller profits were approximately equal over all six trading periods, at 95.2 percent and 93.2 percent of the perfectly efficient standard, respectively. The small traders each earned more than the PES, averaging 3.2 percent "excessive" profits. The small buyers were at 100.3 percent and 102.4 percent, with the small sellers at 102.6 and 107.4 percent. The large traders were well below the PES, at 89.2 percent and 81.6 percent for the buyer and seller, respectively. The 570 contracts amounted to slightly less than eight trades per period, approximately one trade per period less than the maximum potential number of trades per period. The large buyer and large seller engaged in 201 and 212 trades, respectively, out of a possible 216 across all sessions and periods. The smaller traders, on the other hand, negotiated fewer trades, with 180, 189, 178, and 180 contracts for the small buyers and small sellers, respectively, despite often exceeding their PES allocations.

Trades at equilibrium prices would have generated profits for both buyers and sellers up to their "allocations." Zero-sum games were in effect for nonequilibrium prices and for excessive quantities. That is, contract prices above or below the equilibrium price generated rents to the seller or buyer, respectively. Buyers or sellers contracting a profitable trade beyond their allocation did so at the expense of the competition. That is, if a small buyer contracted to purchase (profitably) more than 25 units in a given period, one or more of the other buyers received below-optimal quantities and/or profits, and at least one of the sellers earned suboptimal profits for that period. A profitable trade beyond 25 units for a small buyer would have necessitated a purchase price below the equilibrium price. Over all 72 periods, the 90.1 average trades per period amounted to 40.8 and 49.3 for the large buyer and the small buyers, and 39.6 and 50.5 for the large seller and the small sellers, respectively. The mean prices per trade also favored the smaller traders. On average, the large buyer paid 81.7 cents per unit, while the small buyers paid only 78.7 cents per unit, and the large seller received 76.2 cents per unit compared with 81.8 cents per unit for the small sellers. The smaller traders extracted rents from the larger traders in terms of both nonequilibrium prices and excessive quantities.

A number of paired mean comparisons and analysis of variance (ANOVA) tests were conducted to assess whether profits over the 72 trading periods were statistically different for the six traders (table 1). Results over all periods indicate that none of the profit means for the small traders were significantly different from each other (all statistical tests show a 5-percent significance level unless otherwise specified). Period profits for the large buyer, on the other hand, were significantly smaller than for one of the small buyers and both of the small sellers, and profits for the large seller were significantly smaller than for all four of the small traders. Dropping the transition periods (3 and 6) from the analysis left large buyer profits significantly smaller than those of both small buyers and one small seller, and large seller profits significantly smaller than those of both small buyers and one small seller. Including only the disclosure periods (5 and 8) across all treatments showed large seller profits to be significantly smaller than for every other market participant, including the large buyer. Further bivariate-mean comparisons by trader and type of disclosure were conducted over all trading periods with no significant differences in mean profits.

Comparisons Between Baseline and Disclosure Periods

The periods of interest for further analysis are periods 4, 5, 7, and 8 (table 2). The mean (quantity-weighted) price averaged over all baseline and disclosure periods (for all treatments) moved away from the equilibrium price between the baseline periods and periods 5 and 8. The mean profit over all periods, however, increased somewhat and the standard deviation of profit fell substantially, pointing to some increase in efficiency. Only the standard deviations of profit were sig-

Table 1—Results of paired profit comparisons among all traders

Name	N	Mean profit	Large buyer	Small buyer 1	Small buyer 2	Small seller 1	Small seller 2	Large seller
Over all periods:					*F(1, 142)*			
LB	72	5.35	—					
SB1	72	6.14	5.48*	—				
SB2	72	6.02	2.86	.08	—			
SS1	72	6.15	4.37*	0	.08	—		
SS2	72	6.45	11.78*	.65	1.00	.50	—	
LS	72	4.89	2.54	13.13*	7.89*	10.46*	22.75*	—
Periods 4, 5, 7, and 8:					*F(1, 94)*			
LB	48	5.43	—					
SB1	48	6.16	3.43	—				
SB2	48	6.41	4.74*	.24	—			
SS1	48	5.68	.35	1.10	2.04	—		
SS2	48	6.25	4.51*	.42	.10	1.59	—	
LS	48	4.90	2.28	9.59*	10.77*	3.30	11.45*	—
Periods 5 and 8:					*F(1, 46)*			
LB	24	5.66	—					
SB1	24	6.35	1.46	—				
SB2	24	6.31	1.27	.03	—			
SS1	24	6.03	.69	.31	.23	—		
SS2	24	6.13	.83	.13	.09	.03	—	
LS	24	4.55	6.11*	9.89*	9.23*	10.86*	9.38*	—

F-statistic tests equality of means. *Indicates significant at the 5-percent level. — = not applicable.

nificantly different between the baseline and disclosure periods for all treatments.

The mean price average in the no disclosure treatment dropped toward the equilibrium price between periods 4 and 7 and periods 5 and 8, with the mean profit over all periods increasing slightly and the standard deviation of profit falling slightly but not significantly. These movements in the correct direction can be attributed to learning, since there was no information disclosure, and only during periods 4/5 and 7/8 did supply and demand schedules not shift for the traders. Under the partial disclosure treatment, although the mean price averaged over all periods moved away from the equilibrium between the baseline and disclosure periods, only one trading period reflected a price movement in the wrong direction. Profits increased somewhat between baseline and disclosure, and the 21.2-percent drop in the standard deviation of profits was significant at a 20-percent level. Under full disclosure, there were no price movements in the wrong direction, although profits dropped slightly. The standard deviation of profits fell 24.8 percent, significant at the 5-percent level. We anticipated that both full and partial disclosure would result in enhanced market efficiency in the sense that excessive trader profits would be expected to fall and below-average profits to rise. These decreases in the variance of profits are a first indication of enhanced efficiency with information disclosure.

We obtained more evidence of enhanced market efficiency with information disclosure by looking at specific trader behavior. We calculated deviations from the mean profit level for each trader for each of the nontransition periods (table 3). An efficient market would presumably result in either positive or negative deviations from the mean profit level in the baseline period moving toward (and possibly beyond) zero in the disclosure period. In table 3, a positive sign represents an efficient market movement between the baseline and disclosure period, while a negative sign reflects a movement in the wrong direction. The 48 sets of comparisons of traders for the no disclosure treatment produced only 11 inefficient movements, reflecting (qualitatively) an efficient market. The 12 negative values for the full disclosure treatment represented a slight increase in the number of inefficient movements, while 16 inefficient movements marked the partial disclosure treatment. Although the direction of changes pointed to a slight decline in efficiency following information disclosure, the magnitude of the changes revealed a very different outcome. The average value of the 105 efficient moves was $2.09, and the average of the 39 inefficient moves was 95 cents. The inefficient moves averaged 61 percent of the value of the efficient moves for the no disclosure treatment ($1.25 compared with $2.05), but were 49 percent for the partial treatment ($1.00/$2.05) and 29 percent for the full disclosure treatment (62 cents/$2.16). That is, with information disclosure, market participants tended to encourage movements in the "correct" direction and reacted negatively to increased profits or losses.

Contract prices were also analyzed across all 386 trades negotiated during the baseline and disclosure periods. The dependent variable for this analysis was the trading price less the equilibrium price (TPLEP).

Table 2—Summary data across all traders, by period and treatment

Session/period	Equilibrium price	Mean price	Stan. dev., price	Total units	Number of trades	Mean profit	Stan. dev., profit	Profit efficiency
(No disclosure)		*Cents*			*Number*		*Dollars*	*Percent*
3/4	100	98.55	3.53	87	9	5.99	1.02	99.8
3/5	100	97.89	2.95	87	9	6.02	.87	100.3
3/7	60	72.53	4.56	87	9	5.91	2.99	98.5
3/8	60	67.44	3.42	87	8	5.88	1.75	98.0
4/4	60	75.32	4.44	75	9	5.81	3.86	96.8
4/5	60	71.15	4.09	85	8	5.75	2.54	95.8
4/7	100	97.96	6.42	98	7	6.28	1.74	104.7
4/8	100	99.38	6.39	85	9	5.59	1.30	93.2
7/4	60	64.86	3.17	96	6	5.91	1.53	98.5
7/5	60	56.44	9.43	102	8	6.27	2.70	104.5
7/7	100	101.46	6.05	108	7	5.58	1.57	93.0
7/8	100	94.43	8.90	100	8	5.69	2.45	94.8
11/4	100	99.28	5.76	97	9	5.62	1.32	93.7
11/5	100	107.77	6.29	91	8	5.99	2.60	99.8
11/7	60	66.90	7.71	94	8	6.02	2.54	100.3
11/8	60	61.61	6.84	96	9	6.08	1.68	101.3
PD47	80	84.61	5.21	92.8	8.0	5.89	2.07	98.2
PD58	80	82.01	6.04	91.6	8.4	5.91	1.99	98.5
Total	80	83.31	5.62	92.2	8.2	5.90	2.03	98.3
(Partial disclosure)		*Cents*			*Number*		*Dollars*	*Percent*
1/4	60	73.69	6.31	85	7	5.90	3.34	98.3
1/5	60	65.31	9.31	85	8	5.53	.91	92.2
1/7	100	97.13	8.86	100	8	4.79	3.66	79.8
1/8	100	97.99	4.58	97	7	5.91	1.26	98.5
2/4	100	87.87	5.95	65	7	4.69	2.66	78.2
2/5	100	90.96	7.47	70	7	4.14	2.51	69.0
2/7	60	61.49	11.14	59	8	4.75	1.76	79.2
2/8	60	54.93	11.32	57	7	4.98	2.54	83.0
8/4	60	58.82	9.15	106	8	6.20	2.43	103.3
8/5	60	55.95	8.83	99	7	6.44	2.61	107.2
8/7	100	94.16	3.34	96	8	5.76	1.85	96.0
8/8	100	94.20	5.79	95	8	6.19	2.15	103.2
12/4	100	91.47	5.31	88	9	5.79	2.70	95.6
12/5	100	91.93	5.39	85	8	6.18	2.56	103.0
12/7	60	62.26	5.12	95	8	6.01	1.58	100.2
12/8	60	61.43	5.09	95	8	6.14	1.23	102.3
PD47	80	78.36	6.90	86.8	7.9	5.49	2.50	91.3
PD58	80	76.59	7.22	85.4	7.5	5.69	1.97	94.8
Total	80	77.47	7.06	86.1	7.7	5.59	2.23	93.1
(Full disclosure)		*Cents*			*Number*		*Dollars*	*Percent*
5/4	60	64.19	6.27	88	7	5.85	1.77	97.5
5/5	60	54.35	8.52	87	8	5.91	2.15	98.5
5/7	100	88.66	7.48	95	9	6.29	3.27	104.8
5/8	100	91.78	5.76	96	8	6.23	2.48	103.8
6/4	100	86.72	6.63	87	9	5.97	3.73	99.5
6/5	100	92.92	3.04	93	8	5.84	1.99	97.3
6/7	60	63.68	4.41	97	9	5.98	1.37	99.7
6/8	60	57.32	10.54	99	9	6.55	2.56	109.2
9/4	60	48.62	10.33	84	6	6.36	3.60	106.0
9/5	60	51.64	9.68	95	8	5.37	2.36	89.5
9/7	100	86.93	10.33	84	9	5.29	3.23	88.2
9/8	100	95.62	10.14	86	7	6.04	1.47	100.7
10/4	100	96.32	10.44	89	8	6.00	2.35	100.0
10/5	100	100.15	4.03	88	9	5.74	1.09	95.7
10/7	60	70.70	4.13	88	9	5.80	2.61	96.7
10/8	60	67.76	3.45	91	9	5.71	2.34	95.2
PD47	80	75.73	7.50	89.0	8.3	5.94	2.74	99.1
PD58	80	76.44	6.90	91.9	8.3	5.92	2.06	98.7
Total	80	76.09	7.20	90.4	8.3	5.93	2.40	98.9
(All baseline and disclosure periods)								
PD47	80	79.57	6.54	89.5	8.0	5.77	2.44	96.2
PD58	80	78.35	6.72	89.6	8.0	5.84	2.00	97.3
Total	80	78.96	6.63	89.6	8.0	5.81	2.22	96.8

Table 3—Efficiency of profit movements from baseline to disclosure priods, by trader

Session/periods	Large buyer	Small buyer 1	Small buyer 2	Small seller 1	Small seller 2	Large seller
No disclosure			*Dollars*			
3/4,5	1.31	.17	.78	1.40	1.13	–.61
3/7,8	1.06	2.03	.23	1.89	.22	1.23
4/4,5	.35	2.55	–.26	3.54	1.32	2.23
4/7,8	1.49	.55	4.15	–1.55	.82	–.24
7/4,5	–.36	.57	5.50	–2.22	3.91	4.01
7/7,8	1.42	–2.23	4.42	1.11	5.03	1.31
11/4,5	–1.24	1.16	–3.23	3.21	5.03	2.60
11/7,8	2.26	–.27	.73	–1.59	3.17	1.69
Partial disclosure						
1/4,5	1.56	1.20	4.27	3.83	3.52	–.32
1/7,8	4.25	–.92	.80	6.29	3.12	.64
2/4,5	3.83	6.99	1.44	2.36	1.90	–.36
2/7,8	.26	–1.98	.45	–2.03	1.39	1.51
8/4,5	–.31	2.00	–.61	.46	1.08	–1.68
8/7,8	1.33	.33	–1.21	–.07	.86	–.99
12/4,5	1.55	–2.74	1.70	–.59	1.65	–.56
12/7,8	–.69	–.86	1.13	2.10	.46	1.26
Full disclosure						
5/4,5	2.93	1.10	–1.34	1.44	–1.17	2.77
5/7,8	–.05	–.08	2.18	1.93	.14	–.02
6/4,5	–1.04	.25	4.99	–.09	1.65	2.65
6/7,8	.83	4.21	–.73	1.01	1.89	5.21
9/4,5	4.27	3.70	4.91	3.70	–.43	.23
9/7,8	3.64	.57	1.31	5.42	.98	1.07
10/4,5	2.05	4.37	.41	1.09	–1.02	.61
10/7,8	1.55	.82	–.93	.25	–.53	1.71

The mean of TPLEP over all trades was –0.4 cent, indicating some price advantage to the buyers in the aggregate. Price analysis used ANOVA techniques over one-dimensional, two-dimensional, and three-dimensional classification schemes. One-dimensional schemes included (a) three types of disclosure; (b) baseline periods vs. disclosure periods; (c) high prices in periods 4/5 and low prices in periods 7/8 (HDLS/LDHS) vs. low prices in periods 4/5 and high prices in periods 7/8 (LDHS/HDLS); and (d) various combinations of large and small buyers and sellers.

When prices were analyzed one-dimensionally, TPLEP was found to be significantly different between no disclosure and partial disclosure and between no disclosure and full disclosure; between HDLS/LDHS and LDHS/HDLS; between the large buyer and the large seller; between the large buyer and the small buyers; and between the large seller and the small sellers (with the small traders on each side of the market aggregated into one trader). The significant difference between the high price/low price equilibria is intriguing. Under both schemes, the traders were moving from an equilibrium price of 80 cents in periods 3 and 6 to an equilibrium price of $1 in periods 4 and 5, and 60 cents in periods 7 and 8, or to a price of 60 cents in periods 4 and 5, and $1 in periods 7 and 8. The TPLEP means were 4.66 cents below the HDLS/LDHS equilibria and 2.77 cents above the LDHS/HDLS equilibria. These differences point to the difficulties facing traders as they consistently underestimated the higher prices and overestimated the lower prices.

There was one major surprise in these one-dimensional results: no significant difference between the baseline periods and the disclosure periods. Two-dimensional analyses revealed more about this outcome. The two-dimensional scheme was type of disclosure treatment (NO, PT, FL) by disclosure period (baseline/disclosure)(table 4). The expectation was that the mean TPLEP would move toward zero between the baseline and disclosure periods for all three treatments, and that both partial and full disclosure would enhance this movement. Under no disclosure, the mean TPLEP's between the baseline and disclosure periods were significantly different at a 10-percent level and moved toward zero as expected. Although no significant differences were detected between the mean TPLEP's for either partial of full disclosure, the TPLEP means moved toward zero with full disclosure but diverged from zero with partial disclosure. Here, we have a second bit of evidence of enhanced profiteering under partial disclosure, since in the earlier profits analysis of table 3 partial disclosure had shown the greatest number of inefficient movements between the baseline and disclosure periods.

We extended the two-dimensional scheme to a set of three-dimensional designs by adding variations on trader size and side of the market (buyer/seller), with the same relevant comparison between the baseline

periods and the disclosure periods. Again, we saw no discernible disclosure impacts, although some significant differences were detected between the means in the cells of the two-dimensional and three-dimensional schemes.

The Value of Information Obtained Under Partial Disclosure

From the reported results on profits and prices, we can conclude that disclosure, for the most part, had a positive impact on market efficiency, but that the effect of disclosure on market prices was inconclusive. A logical question to ask is whether disclosure *in fact* had no impact on market prices, or whether the market structure imposed by the experimental design overwhelmed any potential effect of disclosure. The latter explanation has some merit. By looking at the requests for information that were submitted by the traders under the partial disclosure treatment, we can infer a possible excess capacity problem facing the sellers.

The information the traders could have selected revolves around five parameters: side of the market, size of the trader, order of the trade, trading price, and trading quantity. The first two of these parameters centered on a trader's request for information on another trader. Both buyers and sellers mainly requested information on traders from the opposite side of the market (table 5). There were only 6 buyer requests for information on buyers and 7 seller requests for information on sellers (out of 48 possible requests). Information requests on size were likewise fairly equally distributed on each side of the market, with buyers requesting information on a large trader 18 times and sellers requesting large trader information 17 times (again, out of a possible 48).

The last three parameters reflected the type of information requested. There were nine buyer requests and seven seller requests for the largest quantity traded by a given buyer or seller. As expected, no trader requested information on the smallest trade made by another trader. Dramatic differences, however, appeared in price requests and order of trade requests. Buyers requested low price information 31 times and high price information 3 times, as against 16 seller requests for the high price and 3 for the low price. Sellers, on the other hand, on 14 occasions wanted to know the first trade which another trader had made, and requested information on the last trade on 8 occasions. Buyers requested order of trade information only five times. The large seller was especially concerned with order, requesting first trade nine times and last trade twice. The experimental design apparently encouraged (or even forced) market participants to lock in their trades early, which may have contributed to the poor showing on the part of the large traders, especially the large seller, and may have been responsible for the overall downward pressure on prices. The large traders seldom exhibited the market power that the experimental design offered them.

Table 4—Paired mean comparisons of TPLEP, by treatment between baseline and disclosure periods

Type of disclosure	Period	N	Mean TPLEP	Standard deviation	"t" value[1]	Degrees of freedom
			Cents			
None	Baseline (4,7)	64	4.28	9.98	1.68	129
	Disclosure (5,8)	67	1.15	11.32		
Partial	Baseline (4,7)	63	–1.62	12.55	.56	121
	Disclosure (5,8)	60	–2.82	11.20		
Full	Baseline (4,7)	66	–4.14	13.31	.60	130
	Disclosure (5,8)	66	–2.80	12.12		

[1]t-statistic for comparison of means.

Table 5—Summary of information requested under partial disclosure

Request	Number of information requests on trader					
	Large buyer	Small buyer 1	Small buyer 2	Small seller 1	Small seller 2	Large seller
By buyers	2	2	2	15	11	16
By sellers	17	13	11	5	2	0
Total	19	15	13	20	13	16
	Number of information requests on trade					
	First trade	Last trade	Large quantity	Small quantity	High price	Low price
By buyers	2	3	9	0	3	31
By sellers	14	8	7	0	16	3
Total	16	11	16	0	19	34

Conclusions

Our results, unlike those of Hong and Plott, point to enhanced efficiency with information disclosure, with no consistent discernible effects on prices or trading volume. Large differences in the experimental settings, however, precluded direct contrast between the two studies. Their posted price markets differed substantially from our method of information disclosure. Hong and Plott's subjects received information before a new period to be used in the ensuing period, while our subjects used past information for current trading. Hong and Plott also employed 33 subjects (22 sellers and 11 buyers), compared with our use of only one large trader and two small traders on either side of the market.

Our results neither support nor refute Grether and Plott's finding that price-posting policies increased rates in an oligopoly environment, again because of large differences in the laboratory environments. Grether and Plott had nine buyers and four sellers for each experimental session, with two of the sellers controlling 82 percent of the total capacity and no buyer representing more than 30 percent of total market demand. Grether and Plott were concerned with oligopolistic practices on the supply side, while our study was concerned with differential impacts of information disclosure on large and small traders on either side of the market.

Can these results be applied to a real world environment (*17*)? Yes, but with difficulty. Straightforward application of these results to the potential impact of information disclosure on market efficiency or on rail rates between grain shippers and railroads in the South and Central Plains is difficult. Many aspects of the real world environment could not be controlled in the experimental design, including economies of scale and size, different (and continuously changing) technologies and information-gathering systems, and a long history of bargaining over rates between shippers and carriers. However, some aspects of the laboratory experiment may be applicable. Certainly some rail services have gone unused since the early 1980's when overseas grain markets softened. To the extent that the experimental design (unintentionally) fostered a feeling of an excess of supply among the market participants, the current study is relevant.

The impact of partial information disclosure is a particularly intriguing aspect of the experiment. While some results showed contributions to market efficiency with partial disclosure, other results indicated that some traders may have been able to enhance their profits by insightful use of selective information, while other traders may have been hurt by their inability to either select or apply pertinent information. The conclusions suggest that selective contract disclosure may harm market participants who are already being hurt and may offer further advantage to already profitable market participants. The unexpected (but inconclusive) evidence points to enhanced profiteering with partial information disclosure, a conclusion that merits further research.

Preliminary evidence based on an analysis of geographic price spreads shows real rail rates over the study region's major transportation corridors have edged upward since contract disclosure. Rate disclosure may be responsible for the reduced use of grain transport contracts. An estimated 63 percent of rail grain moved under contract in 1986, but by 1988 the share had dropped to 40 percent (*1*). If increased contracting was in fact responsible for lower rates during the early Staggers years, implying more efficient markets, the fear of information disclosure requirements may directly or inadvertently be linked to the decreased number of contracts, contributing to higher rates.[3]

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Appendix A—Representative Demand and Supply Schedules

The following demand and supply schedules reflect low demand for the buyers and high supply for the sellers. Moderate- and high-demand vertical intercepts are $1.30 and $1.50, respectively. Moderate- and low-supply intercepts are 30 cents and 50 cents, respectively. The market summations of one large schedule and two small schedules for each side of the market generate the market demand and supply functions shown in figure 1. The schedules in this appendix show an equilibrium price of 60 cents, which is associated with 50 units transacted by the large traders and 25 units each by the small traders. The 25th and 50th units for the small and large traders, respectively, are "inframarginal" because there is no profit associated with a trade made for the 25th unit for a small trader or the 50th unit for a large trader at the equilibrium price. Hence, 24 + 24 + 49 = 97 units traded is the perfectly efficient solution.

Appendix B—General Instructions

This is an experiment in the economics of market decision making. The instructions are simple, and if you

Table A-1—Buyer schedules for low demand

		Large buyer		Small buyer	
Unit	Resale value	Unit	Resale value	Unit	Resale value
	Dollars		*Dollars*		*Dollars*
1	1.09	41	0.69	1	1.08
2	1.08	42	.68	2	1.06
3	1.07	43	.67	3	1.04
4	1.06	44	.66	4	1.02
5	1.05	45	.65	5	1.00
6	1.04	46	.64	6	.98
7	1.03	47	.63	7	.96
8	1.02	48	.62	8	.94
9	1.01	49	.61	9	.92
10	1.00	50	.60	10	.90
11	.99	51	.59	11	.88
12	.98	52	.58	12	.86
13	.97	53	.57	13	.84
14	.96	54	.56	14	.82
15	.95	55	.55	15	.80
16	.94	56	.54	16	.78
17	.93	57	.53	17	.76
18	.92	58	.52	18	.74
19	.91	59	.51	19	.72
20	.90	60	.50	20	.70
21	.89	61	.49	21	.68
22	.88	62	.48	22	.66
23	.87	63	.47	23	.64
24	.86	64	.46	24	.62
25	.85	65	.45	25	.60
26	.84	66	.44	26	.58
27	.83	67	.43	27	.56
28	.82	68	.42	28	.54
29	.81	69	.41	29	.52
30	.80	70	.40	30	.50
31	.79	71	.39	31	.48
32	.78	72	.38	32	.46
33	.77	63	.37	33	.44
34	.76	74	.36	34	.42
35	.75	75	.35	35	.40
36	.74	76	.34	36	.38
37	.73	77	.33	37	.36
38	.72	78	.32	38	.34
39	.71	79	.31	39	.32
40	.70	80	.30	40	.30
Earnings percentages:		24.49 percent		50 percent	

Telephone numbers:

Seller X	5-XXXX
Seller Y	5-YYYY
Seller Z	5-ZZZZ
Headquarters	5-NNNN

Table A-2—Seller schedules for high supply

Unit	Cost per unit	Large seller: Unit	Large seller: Cost per unit	Small seller: Unit	Small seller: Cost per unit
	Dollars		*Dollars*		*Dollars*
1	0.11	41	0.51	1	0.12
2	.12	42	.52	2	.14
3	.13	43	.53	3	.16
4	.14	44	.54	4	.18
5	.15	45	.55	5	.20
6	.16	46	.56	6	.22
7	.17	47	.57	7	.24
8	.18	48	.58	8	.26
9	.19	49	.59	9	.28
10	.20	50	.60	10	.30
11	.21	51	.61	11	.32
12	.22	52	.62	12	.34
13	.23	53	.63	13	.36
14	.24	54	.64	14	.38
15	.25	55	.65	15	.40
16	.26	56	.66	16	.42
17	.27	57	.67	17	.44
18	.28	58	.68	18	.46
19	.29	59	.69	19	.48
20	.30	60	.70	20	.50
21	.31	61	.71	21	.52
22	.32	62	.72	22	.54
23	.33	73	.73	23	.56
24	.34	64	.74	24	.58
25	.35	65	.75	25	.60
26	.36	66	.76	26	.62
27	.37	67	.77	27	.64
28	.38	68	.78	28	.66
29	.39	69	.79	29	.68
30	.40	70	.80	30	.70
31	.41	71	.81	31	.72
32	.42	72	.82	32	.74
33	.43	73	.83	33	.76
34	.44	74	.84	34	.78
35	.45	75	.85	35	.80
36	.46	76	.86	36	.82
37	.47	77	.87	37	.84
38	.48	78	.88	38	.86
39	.49	79	.89	39	.88
40	.50	80	.90	40	.90
Earnings percentages:		24.49 percent		50 percent	

Telephone numbers:

Buyer A	5-AAAA
Buyer B	5-BBBB
Buyer C	5-CCCC
Headquarters	5-NNNN

follow them carefully and make good decisions, you may earn a considerable amount of money. This experiment simulates a market in which some of you will be buyers and some of you will be sellers in a sequence of trading periods or market days. You will receive an information sheet and a recording sheet labeled BUYER or SELLER which will provide you with information on the number of units available to you to trade, and the cost or value of these tradeable units. THIS IS YOUR OWN PRIVATE INFORMATION. YOU ARE NOT TO REVEAL THIS INFORMATION TO ANYONE.

The market for this commodity is organized as follows. Any buyer (seller) is free at any time during the period to telephone any seller (buyer) and make an oral bid (offer) to buy (sell) one or more units of the commodity at a specific price. Any seller (buyer) is free at any time to accept or not accept the bid (offer) of any buyer (seller). If a bid (offer) is accepted, a binding contract has been closed for the unit(s), and the buyer and seller record the contract price and quantity along with the identification of the other party to the contract. There are likely to be many bids and offers that are not accepted, but you are free to keep trying to generate a trade and to make as much profit as you can. Except for bids (offers) and their acceptance or rejection, you are not to speak to any other buyer or seller. We will begin with two 15-minute training sessions, during which you will practice trading. The price is pre-set during the first training session, so your only concern will be how many units to trade. The quantity traded is pre-set during the second training session and you will be negotiating prices. You will be paid for completing the training sessions. Each subsequent trading period lasts 10 minutes.

Recording sheets will be provided for recording your transactions. For each contract, you are to record (1) the identification of the buyer or seller with whom the trade was made, (2) the contract (transaction) price, and (3) the number of units traded (bought or sold). You should also keep track of your cumulative quantity purchased or sold (the sum of all previous purchases or sales in a trading period) and the resale value or cost per unit of your last unit purchased or sold. At the end of each trading period, we will calculate and report your profit to you for that period and cumulatively.

Specific Instructions

Buyers

During each trading period, buyers may negotiate contracts with sellers to purchase one or more units of a good. These units have pre-set resale values which decline with additional units traded (for example, \$15 for the first unit, \$14 for the second, \$13 for the third, etc.). Purchases are cumulative within a trading period, so resale values continue to decline from one contract to the next. For the units purchased during a trading period, buyers receive a percentage of the profit on the purchases. The profit is equal to the resale value of the unit(s) purchased minus the contract price. Suppose Buyer M negotiates one contract to buy two units from Seller P for \$10 per unit, and negotiates a second contract with Seller Q to buy two more units at a price of \$11 per unit. Suppose the resale values for the respective units were \$15, \$14, \$13, and \$12. The buyer's profit would be (\$15 – \$10) + (\$14 – \$10) + (\$13 – \$11), + (\$12 – \$11), or \$5 + \$4 +

$2 + $1, = $12. If the buyer's earnings percentage were 4 percent, on that purchase he/she would earn 4 percent of $12 or 0.04 * $12 = $0.48 or 48 cents. Note that each succeeding unit has a lower resale value than the previous unit purchased, even when more than one unit is purchased during a transaction. NOTE: IF A BUYER PURCHASES A UNIT FOR WHICH THE PURCHASE PRICE EXCEEDS THE RESALE VALUE, HIS/HER OVERALL PROFIT WILL DECREASE. The recording sheet for the transactions noted above is shown below.

Recording Sheet, Buyer M

	Seller	Purchase Price	Current Quantity Purchased	Cumulative Quantity Purchased	Resale Value of Last Unit Purchased
Contract #1	P	$10.	2	2	$14
Contract #2	Q	$11.	2	4	$12.
Contract #3					

Sellers

During each trading period, sellers may negotiate contracts with buyers to sell one or more units of a good. These units have pre-set costs which increase with additional units traded (for example, $5 for the first unit, $6 for the second, $7 for the third, etc.). Sales are cumulative within a trading period, so costs continue to increase from one contract to the next. For the units sold during a trading period, sellers receive a percentage of the profit on the sales. The profit is equal to the contract price of the units sold minus the cost of the unit(s). Suppose Seller P negotiates one contract to sell two units to Buyer M for $10 per unit, and negotiates a second contract with Buyer N to sell two more units at a price of $11 per unit. Suppose the costs for the respective units were $5, $6, $7 and $8. The seller's profit would be ($10 – $5) + ($10 – $6) + ($11 – $7) + ($11 – $8) = $5 + $4 + $4 + $3 = $16. If the seller's earnings percentage were 4 percent, his/her earnings on that sale would be 4 percent of $16 or 0.04 * $16 = $0.64 or 64 cents. Note that each succeeding unit has a higher cost than the previous unit sold, even when more than one unit is sold during a transaction. NOTE: IF A SELLER SELLS A UNIT AT A PRICE BELOW THE COST OF THE UNIT, HIS/HER OVERALL PROFIT WILL DECREASE. The recording sheet for the transaction noted above is shown below.

Recording Sheet, Seller P

	Buyer	Selling Price	Current Quantity Sold	Cumulative Quantity Sold	Cost per Unit of Last Unit Sold
Contract #1	M	$10.	2	2	$6.
Contract #2	N	$11.	2	4	$8.
Contract #3					

ARE THERE ANY QUESTIONS?

New Instructions for Sellers Following the Training Sessions

From this point on, you are limited to a maximum of THREE contracts each trading period, with no more than one contract allowed with any one buyer. That is, you are allowed to write one contract with Buyer A, one contract with Buyer B, and one contract with Buyer C. You are *allowed* to negotiate a contract with each buyer, but you are not required to do so. Three is simply the maximum number of trades you are allowed to make. There is no limit placed on the number of phone calls you may make to settle your contracts, nor on the number of units within each contract. However, these three contracts must necessarily include all the units which you are willing and able to sell during the trading period. NOTE: The buyers are subject to these same restrictions. If you have questions, please ask them before the beginning of the new trading session.

New Instructions for Buyers Following the Training Sessions

From this point on, you are limited to a maximum of THREE contracts each trading period, with no more than one contract allowed with any one seller. That is, you are allowed to write one contract with Seller X, one contract with Seller Y, and one contract with Seller Z. You are *allowed* to negotiate a contract with

each seller, but you are not required to do so. Three is simply the maximum number of trades you are allowed to make. There is no limit placed on the number of phone calls you may make to settle your contracts, nor on the number of units within each contract. However, these three contracts must necessarily include all the units which you are willing and able to buy during the trading period. NOTE: The sellers are subject to these same restrictions. If you have questions, please ask them before the beginning of the new trading session.

Price Transmission Asymmetry in Pork and Beef Markets

William F. Hahn

Abstract. *Farm, wholesale, and retail prices for beef and pork show significant evidence of asymmetric price interactions. All prices display greater sensitivity to price-increasing shocks than to price-decreasing shocks. The farm beef price, in particular, reacts faster to wholesale price increases than to wholesale price decreases.*

Keywords. *Endogenous switching, pork, beef, asymmetry, price transmission*

The interactions among the farm, wholesale, and retail prices of meats are often controversial, especially when the farm price drops substantially more than the retail price. People often claim that retail prices reflect cost increases more rapidly than cost decreases. This study presents evidence to show that this common suspicion is valid. In the short run, retail prices of beef and pork are more sensitive to price-increasing factors than to price-decreasing factors. Wholesale and farm prices for beef and pork are also more sensitive to price-increasing factors. Both farm and retail beef prices react more strongly to wholesale price increases than to wholesale price decreases.

These asymmetric price responses are measured using a Generalized Switching Model (GSM). Previous research into asymmetric price transmission has been based on Ward's (*13*) Dynamic Asymmetric Markup Model (DAMM).[1]

The GSM is the rough equivalent of a set of unrestricted reduced-form equations for a general set of endogenous switching regressions relating the farm, wholesale, and retail prices of a meat. Although DAMM's are not usually presented as such, they are structural endogenous switching models. Any DAMM can be transformed into a GSM. DAMM's place rather stringent restrictions on the nature of price interactions. The restrictions are that price discovery occurs at the farm level, wholesale prices are determined as a (dynamic, asymmetric) markup over farm prices, and retail prices are determined as a (dynamic, asymmetric) markup over wholesale prices.

GSM's can also be derived from more general models of price interactions. Consequently, GSM's do not require as many assumptions as DAMM's and incorporate a type of asymmetric reaction not found in DAMM's. Price changes in GSM's can be sensitive to their own directions as well as the directions of other prices.

Although the GSM's estimated in this article represent reduced forms, they can be used to make a limited number of inferences about the interaction of prices in the marketing system. The estimates include coefficients which measure the *asymmetry* of interactions between prices. For example, the wholesale price has an asymmetric effect on the farm price if wholesale price increases have a different effect on the farm price than wholesale price decreases. An asymmetric effect implies a nonzero asymmetric interaction coefficient. If the wholesale price has no effect on the farm price, then its effect is symmetric, and its asymmetric interaction coefficient is zero. The reduced-form estimates can be used to test for the existence of asymmetric interactions. If interactions are asymmetric, then they obviously exist. DAMM's imply that wholesale and retail price changes have no effect on the farm price and that retail price changes have no effect on the wholesale price. The significance of these three interaction coefficients can be used as a partial test of the validity of the DAMM's assumptions.[2]

Previous Research

Ward (*13*) invented DAMM's in order to study price transmission in produce markets, extending a methodology devised by Wolffram (*15*). Wolffram's technique involves dividing an independent variable into increases and decreases. Suppose that X_t denotes a variable and DX_t denotes its first difference. Wolffram created four new variables from DX_t: $DXup_t$, $DXdn_t$, $ZXup_t$, and $ZXdn_t$ defined as:

$$DXup_t = DX_t \text{ for } DX_t \geq 0, \text{ 0 otherwise,}$$

$$DXdn_t = DX_t \text{ for } DX_t < 0, \text{ 0 otherwise,}$$

$$ZXup_0 = 0,$$

$$ZXup_t = ZXup_{t-1} + DXup_t, \text{ for } t \geq 1,$$

$$ZXdn_0 = 0,$$

$$ZXdn_t = ZXdn_{t-1} + DXdn_t, \text{ for } t \geq 1.$$

Note that the following relationship holds between the current value of X and the Z variables:

$$X_t = ZXdn_t + ZXup_t + X_0.$$

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[1]Italicized numbers in parentheses cite sources listed in the References section at the end of this article.

[2]The space limitations of a journal article prevent a full test of the implications. See (*4*).

Wolffram's procedure involves regressing the dependent variable on Zup_t and Zdn_t. If the coefficients of both Z's are the same, the reaction of Y to changes in X is symmetric. Wolffram's model was first used to analyze irreversible supply by Tweeten and Quance (*9*) and Houck (*6*). Ward extended the Wolffram method by adding distributed lags of the Z variables, allowing lagged price adjustments. Consider the following example of a DAMM model relating the wholesale price to the farm price:

$$W_t = A_{wf}Fup_t + Cup_{w1}Fup_{t-1} + \ldots. Cup_{wi}ZFup_{t-1} + B_{wf}Fdn_t + Cdn_{w1}Fdn_{t-1} + \ldots. Cdn_{wi}Zfdn_{t-1} + x_tC_w + e_{wt}. \quad (1)$$

W denotes the wholesale price, F denotes the farm price, ZFup and ZFdn are Wolffram-type Z variables constructed from changes in the farm price, x_t is a vector of cost variables and other factors affecting the wholesale/farm margin, e_{wt} is a random error term, and the A's, B's, and C's are parameters. The retail price in time t, which will be included elsewhere in the model, will be denoted by R_t. Equation 1 is somewhat different than the typical DAMM. Ward used distributed lags of the Z variables, and equation 1 uses the Z variables only in the ultimate lags.[3]

DAMM's allow current and lagged farm price increases to have a different effect than current and lagged farm price decreases. The coefficients on the ZF variables measure the ultimate effects of farm price changes on the wholesale price. If the two coefficients are the same, farm price changes have symmetric effects on the longrun wholesale price.[4] Ward's model allows price transmission asymmetry to be a longrun or shortrun phenomenon.

DAMM's have also been applied to modeling retail pricing. The structure of a retail pricing model is similar to that of equation 1, with the retail price replacing the wholesale price as the dependent variable, and functions of the wholesale price replacing farm prices in the set of predetermined variables. DAMM's were used by Boyd and Brorsen (*1*) to study price transmission in pork markets, and by Kinucan and Forker (*8*) who studied price transmission in milk markets.

Previous modelers have estimated DAMM's using least squares. There is potential simultaneity between the farm and wholesale and retail prices which would make least-squares estimates of DAMM's biased and inconsistent. However, if price setting is a recursive process, in which price shocks occur first at the farm level, and spread upwards from there, then DAMM models could be estimated by least squares.

The analyst should check to see if the pricing process is recursive prior to estimating a DAMM. Causality tests can be used to test the hypothesis that pricing is a recursive process (*5*). Heien examined price relationships with mixed results in several agricultural marketing channels. Markup pricing was relatively common but not universal. Wohlgenant showed that under certain restrictive conditions, the farm price would lead retail prices (*14*). His tests demonstrated that monthly farm prices for cattle led retail beef prices. The causality tests used by Heien and Wohlgenant, however, are not appropriate if price interactions are asymmetric. Causality tests are based on linear models, but asymmetric price transmission is a nonlinear process.

DAMM's represent a class of endogenous switching models, where one or more of the coefficients is a function of endogenous variables. The farm price is an endogenous variable whose coefficient in equation 1 switches depending on the direction of the farm price change. While the DAMM represents a particular type of endogenous switching model, it is not the most fully general asymmetric markup model one can derive.

Generalizing the DAMM and Deriving the GSM

A more general version of the DAMM can be written as follows:

Retail Equation

$$Rup_t + B_{rr}Rdn_t + A_{rw}Wup_t + B_{rw}Wdn_t = Cup_{rw,1}Fup_{t-1} + \ldots. Cup_{rw,i}ZWup_{t-i} + Cdn_{rw,1}Wdn_{t-1} + \ldots. Cdn_{rw,i}ZWdn_{t-i} + Cup_{rr,1}Rup_{t-1} + \ldots. Cup_{rr,i}ZRup_{t-i} + Cdn_{rr,1}Rdn_{t-1} + \ldots. Cdn_{rr,i}ZRdn_{t-i} + x_tC_r + e_{rt}. \quad (2)$$

Wholesale Equation

$$Wup_t + B_{ww}Wdn_t + A_{wf}Fup_t + B_{wf}Fdn_t = Cup_{wf,1}Fup_{t-1} + \ldots. Cup_{wf,i}ZFup_{t-i} + Cdn_{wf,1}Fdn_{t-1} + \ldots. Cdn_{wf,i}ZFdn_{t-1} + Cup_{ww,1}Wup_{t-1} + \ldots. Cup_{ww,i}ZWup_{t-i} + Cdn_{ww,1}Wdn_{t-1} + \ldots. Cdn_{ww,i}ZWdn_{t-i} + x_tC_w + e_{wt}. \quad (3)$$

[3]This deviation from Ward's methodology simplifies a hypothesis test and reduces multicollinearity because the lagged Z variables are highly correlated.

[4]If equation 1 were written as a distributed lag of Z variables, longrun symmetric effects would imply that the sums of the Zup and Zdn coefficients were the same.

Farm Equation

$$Fup_t + B_{ff}Fdn_t = Cup_{ff,1}Fup_{t-1} + \ldots. Cup_{ff,i}ZFup_{t-1} + Cdn_{ff,1}Fdn_{t-1} + \ldots. Cdn_{ff,i}ZFdn_{t-i}\ x_tC_f + e_{ft}. \quad (4)$$

For the three-equation system above to represent a true markup process, the error terms of all three equations must be independent of one another.

Note how equation 3, the wholesale equation, differs from equation 1. First, equation 3 includes distributed lags of the wholesale price increases and wholesale price decreases. This allows for more complex lagged responses. More important, the current change in the wholesale price (the endogenous variable) has been split into increases and decreases. The coefficient B_{ww} measures the asymmetry of the wholesale price in response to its own direction.

The coefficients B_{rr}, B_{ww}, and B_{ff} must all be positive for the system above to be coherent. All simultaneous equation systems must meet coherency conditions before they can be estimated (*2*). Coherency is roughly the opposite of identification. Coherency conditions ensure that the model's reduced form can be derived from its structural form. Identification conditions ensure that the structural equation can be derived from its reduced form.

Coherency ensures that each combination of predetermined variables and error terms implies just one set of endogenous variables. Consider the following truncated version of equation 3:

$$Wup_t + B_{ww}Wdn_t = \text{(right-hand side)}. \quad (3a)$$

If B_{ww} is positive, any value of the right-hand side implies only one solution for the left-hand side. When the right-hand side is negative, Wup is zero and Wdn is the right-hand side divided by B_{ww}. When the right-hand side is negative, Wup equals the right-hand side and Wdn is zero. If the right-hand side is zero, both Wup and Wdn are zero. If, however, B_{ww} is negative or zero, equation 3a cannot be solved whenever the right-hand side is negative. More than one solution exists when the right-hand side is positive.

If B_{ww} is equal to 1, Wup_t and Wdn_t can be rejoined to make the change in the wholesale price and wholesale price changes are symmetric in their own direction. B_{ww} allows modeling wholesale price reactions when packers react asymmetrically to changes in total cost and not just to changes in the farm price. If B_{ww} is 1, then the terms Wup_t and Wdn_t in equation 3 can be recombined to the change in the wholesale price. Whenever B_{ww} is greater than 1, the wholesale price will be more sensitive to price-increasing shocks than to price-decreasing shocks. A B_{ww} that is less than 1 implies that the wholesale price is more sensitive to price-decreasing shocks. A value of B_{ww} greater than 1 would imply that wholesale prices adjust more quickly upward than downward if other factors (including the effects of lagged wholesale prices) had symmetric effects on the wholesale price.

To derive the generalized switching model, note that the system outlined in equations 2, 3, and 4 can be written:

$$yup_tA + ydn_tB = x_tC + e_t, \quad (5)$$

where:

$yup_t = \{Rup_t, Wup_t, Fup_t\}$,

$ydn_t = \{Rdn_t, Wdn_t, Fdn_t\}$,

e_t is a (1 by 3) vector of error terms,

A and B are (3 by 3) matrices of coefficients,[5]

x_t is redefined to be the vector of all the predetermined variables, including the Z's and lagged increases and decreases, and

C is a matrix of coefficients of all the predetermined variables.

The system in 4 would represent a linear system of simultaneous restrictions if the matrix A equaled the matrix B. To the extent that A and B differ, price interactions are asymmetric.

Not only can the system in 5 represent that of equations 2, 3, and 4, it may also represent other systems of endogenous switching models. Any generalization of the system in 5 must also meet coherency conditions. The coherency condition for linear simultaneous equation systems is fairly simple. The system specified in 3 is a linear system if A and B is equal, and the system will be coherent if the matrix A has full rank. If the matrix A has full rank, then one can derive a reduced form. If the model is identified or overidentified, the reduced form can be used to derive the structural parameters. The requirement of coherency restricts the ranges of the possible values of the matrix A.

The coherency conditions also limit the possible ranges of matrices A and B of switching models. Note that equation 5 can be written:

$$y_tM(y_t) = x_tC + e_t. \quad (6)$$

The matrix $M(y_t)$ takes one of eight forms. When the retail price is increasing, the first row of $M(y_t)$ is the first row of the matrix A. When the retail price is

[5]A and B must meet coherency conditions discussed later.

decreasing, the first row of $M(y_t)$ is the first row of the matrix B. The second and third rows of $M(y_t)$ depend on the signs of the wholesale and farm price changes, respectively.

Gourieroux, Laffont, and Monfort (2) have noted that such endogenous switching models as specified in 5 and 6 are coherent if all their matrices M are of full rank and if all the determinants of the M matrices have the same sign. If the model is coherent, the reduced form can be written:

$$y_t = M^{-1}(y_t)\,(x_tC + e_t). \tag{7}$$

Coherency conditions restrict the potential ranges of the A and B coefficients. For this article, I assumed that meat prices were determined within a coherent system. The assumption of coherency is implicit in all applied econometric work. The estimation algorithm used in this study can only produce matrices A and B estimates that result in all eight matrices M having positive determinants.[6]

The reduced form in 7 is rather inconvenient to estimate, especially for underidentified systems. The GSM is a "semireduced" form created by multiplying equation 5 from the right by A^{-1}:

$$yup_t + ydn_tB^* = x_tC^* + e_t^*, \tag{8}$$

where, B^* is BA^{-1}, C^* is CA^{-1}, and e_t^* is e_tA^{-1}.

The system in 8 defines the GSM. The GSM can be written in expanded form as:

$$Rup_t + BrrRdn_t + BrwWdn_t + BrfFdn_t = x_tc_r^* + e_{r,t}^*, \tag{9}$$

$$Wup_t + BwrRdn_t + BwwWdn_t + BwfFdn_t = x_tc_w^* + e_{w,t}^*, \text{ and} \tag{10}$$

$$Fup_t + BfrRdn_t + BfwWdn_t + BffFdn_t = x_tc_f^* + e_{f,t}^*. \tag{11}$$

Coherency limits the range of allowable B coefficients. If the GSM is to be estimated, it must be also be identified. Before discussing the identification problem, consider how coherency limits the B estimates.

Coherency Conditions

For the GSM to be coherent, the determinants of each of its eight $A(y_t)$ must have the same sign. These eight matrices and their associated regimes are:

$$M(0) = \begin{bmatrix} Brr, & Bwr, & Bfr \\ Brw, & Bww, & Bfw \\ Brf, & Bwf, & Bff \end{bmatrix}$$

$$\begin{aligned} Det(M(0)) = {} & Brr*Bww*Bff - Brr*Bwf*Bfw \\ & + Bwr*Bfw*Brf - Bww*Brf*Bfr \\ & + Bfr*Brw*Bwf - Bff*Brw*Bwr \end{aligned}$$

$$M(1) = \begin{bmatrix} Brr, & Bwr & Bfr \\ Brw, & Bww, & Bfw \\ 0, & 0, & 1 \end{bmatrix}$$

$$Det(M(1)) = Brr*Bww - Brw*Bwr$$

$$M(2) = \begin{bmatrix} Brr, & Brw, & Bfr \\ 0, & 1, & 0 \\ Brf, & Bwf, & Bff \end{bmatrix}$$

$$Det(M(2)) = Brr*Bff - Brf*Bfr$$

$$M(3) = \begin{bmatrix} Brr, & Bwr & Bfr \\ 0, & 1, & 0 \\ 0, & 0, & 1 \end{bmatrix}$$

$$Det(M(3)) = Brr$$

$$M(4) = \begin{bmatrix} 1, & 0, & 0 \\ Brw, & Bww, & Bfw \\ Brf, & Bwf, & Bff \end{bmatrix}$$

$$Det(M(4)) = Bff*Bww - Bwf*Vfw$$

$$M(5) = \begin{bmatrix} 1, & 0, & 0 \\ Brw, & Bww, & Bfw \\ 0, & 0, & 1 \end{bmatrix}$$

$$Det(M(1)) = Bww$$

$$M(6) = \begin{bmatrix} 1, & 0, & 0 \\ 0, & 1, & 0 \\ Brf, & Bwf, & Bff \end{bmatrix}$$

$$Det(M(6)) = Bff$$

$$M(7) = \begin{bmatrix} 1, & 0, & 0, \\ 0, & 1, & 0 \\ 0, & 0, & 1 \end{bmatrix}$$

$$Det(M(7)) = 1$$

The matrices have been numbered by counting retail price increases as a 4, wholesale price increases as a 2, farm price increases as a 1, and all price decreases as zeros. This numbering system will be retained throughout the article.

The matrix M_7, which is associated with all prices

[6]The algorithm takes the logarithm of each estimated matrix M's determinant and will not allow matrices M with negative determinants.

increasing, is the identity matrix. Its determinant is 1, a positive number. The other seven determinants must also be positive. Note that the determinants of M_6, M_5, and M_3 are Bff, Bww, and Brr, respectively. Coherency requires that the diagonal elements of the B* matrix be strictly greater than zero.

Reduced-form parameters can be derived from those of the GSM. The reduced-form changes depend upon the directions of the prices in equation 7. The estimated C coefficients and the variance/covariance structure of the GSM are the reduced-form parameters for regime 7, in which all prices are increasing. (The M matrix for regime 7 is the identity matrix, equal to its own inverse.) The estimated B coefficients can be used to derive the reduced forms for the other regimes.

One advantage of using regime 7 as the base regime is that it simplifies the interpretation of the off-diagonal elements of the matrix B. These off-diagonal elements provide a crude measure of the asymmetry of the feedback from one price to another. For example, if farm price increases have a greater initial impact on the wholesale price than farm price declines, then the coefficient B_{wf} will be positive. If farm price declines have a greater initial impact on the wholesale price, then B_{wf} will be negative.

Identification

The identification of the GSM can be demonstrated in two ways. If a system of equations is identified (and coherent), then its maximum likelihood estimates exist and are unique. Maximum likelihood estimation yielded unique values, proving that the system is identified. As more proof of model identification, we see that there are no nontrivial linear combinations of the model's equations that meet the same restrictions as its structural form. All the price increases are multiplied by the identity matrix in the GSM. Any attempt to transform the GSM will produce a model where the price increases are not multiplied by the identity matrix.

Econometric Issues

The GSM's for beef and pork are estimated using a three-stage procedure. In the first and last steps, I estimated the full model by using maximum likelihood estimation (MLE). The intermediate step is a model specification step in which restrictions are placed on the coefficients of the lagged endogenous variables. These restrictions are used in the last stage.

Data and Specifying the Lag Structure

The GSM combines features of switching models and vector autoregressive models. In the GSM, current changes in retail, wholesale, and farm prices are related to lagged price increases and declines, lagged Z variables, an intercept, a trend, and the Consumer Price Index (CPI). The trend and the CPI account for factors that have affected margins over time. Both the pork and beef models used 378 observations of weekly price changes, with the sample period starting in the first week of 1980 (table 1). In initial runs, 6-week lags were used. The model can also be viewed as an asymmetric, rational lag model. Research has indicated that rational lag models with 3 or 4 lags can closely approximate most patterns of lagged adjustment (*3*). So, a 6-week lag should be more than sufficient and may even overfit the model. After the initial runs, the models' specifications were tightened by imposing restrictions on the predetermined variable coefficients.

Given the values of the B coefficients, the C coefficients can be estimated by least squares. So, in the first stage, all the coefficients of the models were estimated by MLE. Then, given fixed estimates of the B coefficients, various restrictions on the C matrices were tested. The restrictions were tested jointly on all three equations using a chi square test with three degrees of freedom and an alpha of 10 percent. A series of restrictions were tested; the least significant was then imposed on the estimates, and the remaining restrictions were retested. The process was repeated until there were no more insignificant restrictions.

Table 1—Data sources and their derivations

The data set contained price and cost data for 378 weeks, starting with the week ending January 5, 1980, and ending with the week of March 28, 1987. Earlier observations were lost because of the lags and difference. The price series is based on the monthly data used by USDA to calculate pork and beef price spreads. Proportional changes in observed weekly prices were used as indices to move the monthly data.

R_t	The weekly retail price indices were taken from national average pork- and beef-cut prices as reported by the Knight Ridder News Service.
W_t, F_t	The farm and wholesale prices for pork and beef were based on prices reported in *Livestock, Meat and Wool News (11)*. The farm price indices were the seven or eight market barrow and gilt prices for pork and the price of Choice steers in Omaha for beef. The wholesale indices were a weighted average of wholesale pork cuts, and weekly prices for Choice 3 steer carcasses.
CPI_t	Consumer price index in week t. The CPI was collected from selected issues of *Survey Of Current Business*, published by the U.S. Department of Commerce (*12*). Monthly changes in these variables were distributed over weeks.

The restrictions were of two varieties. In the first variety, the coefficient of a lagged variable was set equal to that of the earlier or later lag of the same

variable. This first set of restrictions can transform the 6-week lags into 5-week or shorter lags. In the second set of restrictions, the coefficient for a lagged increase was set equal to that of its matching lagged decline. Restrictions of this type imply that the lagged increase and decline have symmetric effects. This last set of restrictions is particularly important, for if the coefficients of all the Zup's equal those of the matching Zdn's, then price adjustment is reversible.

The model specification procedure selected is rather conservative because it is more likely to reject a restriction. Testing based on a fixed B estimate makes a rejection more likely than if the B were allowed to vary. Also, for vector autoregression problems, Judge and others suggest the use of the Final Prediction Error (FPE) criteria for model selection (*7*). Given the sample size used in this study, the FPE is more likely to accept a restriction than the likelihood ratio test.

Estimating the GSM

The meat price model can be estimated by maximum likelihood if the probability density function (PDF) of the change in prices is known. The PDF of the change in prices can be derived from that of the error term by using a generalization of an elementary theorem from mathematical statistics (*9*, p. 211). Suppose that the error vector is continuously distributed with probability density function $f(e_t)$, then the probability density function of y_t is:

$$f(yup_tA + ydn_tB - x_tC)*det(M_i(y_t)), \quad (12)$$

where the function det() denotes the determinant of a matrix and $M_i(y_t)$ is the matrix M associated with the regime implied by y_t. The probability density function implied by equation 12 is discontinuous at each point where a price change is equal to zero. Equation 12 holds locally for price changes in the interior of the regimes. Given normally distributed errors, the likelihood of observing no change is zero. A price that does not change could be arbitrarily called an increase or a decrease.

There were weeks when some prices did not change. Lumping prices that do not change with either increases or decreases affects the likelihood function by changing the matrix $M(y_t)$. I estimated each model three times to see how sensitive the estimates were to the treatment of zeros. First, prices that did not change were called price increases, then unchanged prices were called declines, followed by treating unchanged prices as half increase and half decrease. (Table 2 shows how differences in the treatment of zero values affects the specification of the regimes.)

While the likelihood function is discontinuous in the price changes as long as zero values are assigned to one orthant or the other, that function is everywhere continuous in its parameters. The real problem with the discontinuity of the likelihood function lies in determining the statistical properties of the estimates.

Table 2—Regime counts from sample period for pork and beef

Regime	Directions: Retail	Wholesale	Farm	Counting zeros as: Increases	Decreases	Averages
Pork data regime:						
7	Up	Up	Up	67	65	66
6	Up	Up	Down	24	23	23.5
5	Up	Down	Up	27	23	25
4	Up	Down	Down	74	78	76
3	Down	Up	Up	59	58	58.5
2	Down	Up	Down	33	35	34
1	Down	Down	Up	26	26	26
0	Down	Down	Down	68	70	69
Beef data regime:						
7	Up	Up	Up	74	68	71
6	Up	Up	Down	15	13	14
5	Up	Down	Up	26	30	28
4	Up	Down	Down	72	72	72
3	Down	Up	Up	64	64	64
2	Down	Up	Down	27	27	27
1	Down	Down	Up	18	20	19
0	Down	Down	Down	82	84	83

Summary of instantaneous price transmission[1]

	Pork	Beef
	Percent	
Retail and wholesale prices move in same direction	48.8	49.5
Retail and farm prices move in same direction	51.3	55.3
Wholesale and farm prices move in the same direction	71.3	76.7
All three prices move in the same direction	38.4	41.0

[1]Percentages are based on treating no change as half increase, half decrease.

Endogenous switching models share a problem in common with logit, probit, and other discrete dependent variable models in that, *a priori*, there is a finite chance that the model will not converge to unique estimates for one or more parameters. In the endogenous switching model, some parameter estimates will not exist if one or more of the prices is monotonic throughout the sample period. This article will use the asymptotic properties of maximum likelihood estimates to justify the hypothesis tests and standard error calculations much the same that applied researchers handle discrete dependent variable models.

I estimated the GSM's under the assumption that the error vectors were independently and identically distributed over time as a multivariate normal process. Given the assumption of normality, the logarithm likelihood function for the switching model for one observation can be written:

$$(2\pi)^{-3/2} \det(\Sigma)^{-1/2} \exp(-e_t\Sigma^{-1}e_t'/2)\det(M(y)), \qquad (17)$$

where:

$$e_t = yup_t + ydn_tB - x_tC,$$

and Σ denotes the variance/covariance of the error terms and the function exp() denotes the base of the natural logarithms, e, raised to the power in parentheses. The sample likelihood function implied by 17 was used to derive the estimates of the models' parameters.

The Results

The treatment of zeros had little effect on the estimates of either pork or beef models, and no effect on the restrictions implied by the model specification step. Table 3 shows the restrictions on the C coefficient estimates for both pork and beef. The one set of restrictions for both was not sensitive to the specification of the zeros.[7] In the pork model, 63 coefficients were eliminated, and in the beef model, 54 coefficients were eliminated.

Pork prices showed evidence of irreversible price adjustment. Both farm and wholesale price changes had different effects in the long run depending on whether they were increases or declines. Conversely, beef price changes were reversible over the long run. Price increases and declines also showed a different lag structure. For pork, retail price increases affected prices with a 5-week lag. Retail price drops took a full 6-week lag. Wholesale price declines worked through a 4-week lag, and increases through a 5-week lag. Farm pork price increases also worked through a longer lag than declines. Farm price drops had a lag of only 2 weeks, while farm price increases have lagged effects for 5 weeks. The beef price structure had 6-week lags for retail increases and declines and farm price increases. Wholesale prices worked through a 4-week lag. Farm price increases had a 6-week lag, while declines had a 5-week lag.

[7]In fact, when I accidently used pork B's with the beef data, I still got the same set of restrictions on the C matrix that I got with the beef B's.

Table 3—Restrictions on the C parameter estimates[1]

Pork restrictions

Rupt-1	Rdnt-1	Wupt-1	Wdnt-1	Fupt-1	Fdnt-1
Rput-2	Rdnt-2	Wupt-2	Wdnt-2	Fupt-2	Fdnt-2
Rupt-3	Rdnt-3	Wupt-3	Wdnt-3	Fupt-3	Fdnt-3
Rupt-4	Rdnt-4	Wupt-4	Wdnt-4	Fupt-4	Fdnt-4
Rupt-5	Rdnt-5	Wupt-5	Wdnt-5	Fupt-5	Fdnt-5
ZRupt-6	ZRdnt-6	ZWupt-6	ZWdnt-6	ZFupt-6	ZFdnt-6

Beef restrictions

Rupt-1	Rdnt-1	Wupt-1	Wdnt-1	Fupt-1	Fdnt-1
Rupt-2	Rdnt-2	Wupt-2	Wdnt-2	Fupt-2	Fdnt-2
Rupt-3	Rdnt-3	Wupt-3	Wdnt-3	Fupt-3	Fdnt-3
Rupt-4	Rdnt-4	Wupt-4	Wdnt-4	Fupt-4	Fdnt-4
Rupt-5	Rdnt-5	Wupt-5	Wdnt-5	Fupt-5	Fdnt-5
ZRupt-6	ZRdnt-6	ZWupt-6	ZWdnt-6	ZFupt-6	ZFdnt-6

[1]All variables in a box have the same effect on price system.

Final Stage Estimates

Table 4 shows the B coefficient estimates and Z tests for all the beef and pork models. The Z tests are based on the information matrix. The null hypothesis for the off-diagonal elements is that the coefficient is 0. The diagonal elements are tested against the null hypothesis that the true value of the coefficient is 1.

In all the models, the diagonal elements are greater than 1, implying that prices in meat-marketing channels are more sensitive to price-increasing shocks than to price-decreasing shocks. The B_{rr} for (retail) beef prices and B_{ff} for (farm) pork prices are both around 1.5, implying that these prices are about two-thirds more sensitive to price-increasing shocks than they are to price-decreasing shocks.

In the pork model, only the coefficient B_{ff} is significant at the 5-percent level. Although most of the estimated off-diagonal coefficients are relatively close to zero, the largest in absolute value is the B_{fw}, which measures the asymmetry of the wholesale price on the retail price. This coefficient is –0.16, suggesting that the retail price of pork is somewhat more sensitive to wholesale price declines than to wholesale price increases.

Beef shows larger asymmetry coefficients than pork. Few of these coefficients are significant despite their size. The interaction coefficients in the retail price equation are particularly large: B_{rw} is 0.6 and B_{rf} is 0.5. These estimates imply that the retail price of beef is much more sensitive to wholesale and farm price increases than decreases. These estimates are not, however, statistically significant at the 5-percent level. The one interaction estimate that is significant is that for B_{fw}, which is approximately 0.4. This estimate implies that the farm price of beef is more sensitive to wholesale price increases than to wholesale price decreases. The significant asymmetric effect that the beef wholesale price has on the beef farm price implies that beef wholesale prices are not determined by a markup process. The significance of the coefficient B_{rr} implies that retail beef prices cannot be adequately modeled with the Wolffram/Ward methodology.

The pork and beef estimates imply that retail and wholesale price increases have a larger immediate impact on farm prices than retail and wholesale price declines. Both farm prices are more sensitive to price-increasing shocks than to price-decreasing shocks. Price transmission asymmetry does not seem to be working against producers, at least not in the very short run.

Table 4 contains a joint test of the significance of the B estimates, where the GSM's are compared with an alternative whose B matrix is restricted to the identity matrix. The joint test statistics for both beef and pork

Table 4—B estimates and test statistics for generalized switching models[1]

	Zeros are ups		Zeros are half up, half down		Zeros are downs	
Coefficient	Estimate	Z value	Estimate	Z value	Estimate	Z value
Pork estimates:						
Brr	1.1235	1.51	1.1325	1.61	1.1416	1.71
Brw	–.1610	–.71	–.1628	–.72	–.1650	–.72
Brf	.1279	.32	.1400	.35	.1528	.38
Bwr	.1023	1.31	.1044	1.32	.1066	1.34
Bww	1.1479	1.47	1.1520	1.49	1.1555	1.50
Bwf	–.0262	–.08	.0022	.01	.0332	.09
Bfr	.1033	1.60	.1053	1.60	.1073	1.61
Bfw	.0459	.30	.0366	.23	.0262	.17
Bff	1.4657	3.25	1.5062	3.48	1.5481	3.72
Joint test of significance of B estimates[2]	35.04		35.09		35.35	
Beef estimates:						
Brr	1.5273	4.70	1.5134	4.64	1.4997	4.57
Brw	.6468	1.79	.6332	1.81	.6193	1.82
Brf	.5334	1.46	.5371	1.49	.5413	1.53
Bwr	–.0596	–.94	–.0581	–.93	–.0565	–.92
Bww	1.1972	1.99	1.1644	1.71	1.1317	1.40
Bwf	–.1418	–1.03	–.1186	–.87	–.0944	–.70
Bfr	.0556	–.67	.0569	.69	.0583	.72
Bfw	.4394	2.50	.3987	2.33	.3571	2.15
Bff	1.2489	1.83	1.2656	1.99	1.2827	2.15
Joint test of significance of B estimates[2]	77.20		76.13		75.35	

[1]Test statistics are based on variances derived from Kramer/Rao lower bound. The null hypothesis for Brr, Bww, and Bff is that the coefficient is 1; the null hypothesis for the other parameter estimates is that they are 0.

[2]Asymptotic chi square with 6 degrees of freedom. 95-percent critical value is 12.6.

are significant at the 0.1-percent level, supporting the hypothesis that asymmetry is an important factor in very shortrun price interactions.

Tables 5 and 6 have the C matrix estimates for pork and beef, respectively. The lagged retail prices have significant and negative effects in the current retail price equation for both meats, and lagged wholesale prices have negative and significant effects in the current wholesale price equation. The farm price equations show fewer significant variables than the others.

Conclusions

Pork and beef prices show evidence of asymmetric price interactions. Prices at all levels of the marketing channel tend to react more strongly in the short run to price-increasing shocks than the price-decreasing shocks. This tendency is most pronounced and most significant in retail prices. There is also evidence of asymmetric interactions among the prices.

Asymmetry is a significant factor in meat pricing, but

Table 5—C matrix estimates and significance tests for pork GSM[1,2]

	Retail		Wholesale		Farm	
Coefficient	Estimate	Z value	Estimate	Z value	Estimate	Z value
Rup_{t-1}	−0.8676	−12.85	−0.0831	−1.76	−0.0252	−0.64
Rup_{t-2}	−1.2212	−14.15	−.0347	−.57	−.0710	−1.41
Rup_{t-3}&Co	−.5731	−7.84	−.0757	−1.48	−.0612	−1.43
Rup_{t-5}&Co	−.3601	−8.15	−.0479	−1.55	−.0301	−1.17
Rdn_{t-1}	−1.2294	−15.73	−.0343	−.63	−.0300	−.66
Rdn_{t-2}	−.6964	−7.66	−.1354	−2.13	−.0773	−1.46
Rdn_{t-3}	−9.8942	−9.69	−.0750	−1.16	−.1124	−2.09
Wup_{t-1}&Co	.0320	.39	−.6262	−10.78	−.0885	1.83
Wup_{t-3}&Co	.0215	.21	−.3865	−5.51	−.1160	1.98
Wup_{t-5}&Co	.1109	1.14	−.3121	−4.60	.0593	1.05
Wdn_{t-4}&Co	.2020	2.09	−.2799	−4.14	.0814	1.45
Fup_{t-1}&Co	−.0632	−.54	.6783	8.27	.3115	4.56
Fup_{t-2}&Co	.4938	4.04	−.6737	7.88	.0122	.17
Fdn_{t-2}&Co	.3205	3.83	−.2340	4.00	−.1042	−2.14
Fup_{t-5}&Co	.2608	2.53	.3643	5.05	−.0780	−1.30
INTERCEPT	13.8124	1.23	−14.4892	−1.84	−8.3507	−1.27
$TREND_t$	.1905	2.78	−0.0876	−1.83	−.0001	0
CPI_t	−.0634	−1.39	.0575	1.80	.0327	1.23

[1]For the B matrix estimates given assumption that zeros are half increase, half decrease.
[2]Hypothesis test for fixed B estimate.

Table 6—C matrix estimates and significance tests for beef GSM[1,2]

	Retail		Wholesale		Farm	
Coefficient	Estimate	Z value	Estimate	Z value	Estimate	Z value
Rup_{t-1}	−1.6870	−24.20	0.1625	5.39	0.0183	0.47
Rup_{t-2}&Co	−1.5022	−18.52	.1119	3.19	−.0198	−.43
Rup_{t-4}	−1.3884	−11.37	−.0651	−1.23	−.0541	−.79
Rup_{t-5}	−1.1329	−8.78	.0091	.16	−.0943	−1.30
Rdn_{t-1}	−.8099	−10.58	−.0388	1.17	.0307	−.71
Rdn_{t-3}&Co	−1.4612	−14.97	.0610	1.45	−.0359	−.65
Rdn_{t-5}	−1.2682	−11.09	−.0411	−.83	−.0054	−.08
R_{t-6}	−1.1021	−9.22	−.1184	−2.29	−.1470	−2.19
Wup_{t-1}	−.0915	−.41	−.4307	−4.45	.5624	4.47
Wup_{t-2}&Co	.6361	3.00	−.5782	−6.31	.3097	2.60
Wup_{t-3}	.4117	1.73	−.7020	−6.80	.0922	−.69
Wdn_{t-1}	.3891	1.75	−.8789	−9.14	.1698	1.36
W_{t-4}	.6050	3.11	−.5237	−6.23	.631	.58
Fup_{t-1}	−.5833	−3.17	.3446	4.33	−.8020	−7.74
Fup_{t-2}	−.3136	−1.36	.6100	6.10	−.1107	−.85
Fup_{t-4}	.0843	.37	−.5418	5.52	.0880	.69
Fup_{t-5}	−.1432	−.65	.2662	2.81	−.2656	−2.16
Fdn_{t-1}&Co	−.1883	−1.19	.4505	6.60	−.2127	−2.40
F_{t-6}&Co	.0295	.17	.3746	5.03	−.1073	−1.11
INTERCEPT	−75.7816	−3.72	−15.2946	−1.74	−9.1805	−.80
TREND	−.0692	−3.02	−.0326	−3.29	−.0138	−1.07
CPI	.3497	4.09	.0699	1.89	.0406	.84

[1]For the B matrix estimates given assumption that zeros are half increase, half decrease.
[2]Hypothesis test for fixed B estimate.

how does it occur? Further research in this area is warranted. Pricing asymmetry could be a rich topic for theoretical and applied research. Applying endogenous switching models in future investigations of meat-pricing practices may be useful.

The use of semireduced-form endogenous switching models could be applied to the study of other economic variables. An obvious area for additional research is price interactions in other agricultural markets. This technique can be applied to the study of any set of potentially interrelated variables.

Estimating semireduced-form switching models is advantageous because they allow the researcher to make limited inferences about the structure of the underlying system. The asymmetric feedback coefficients permit the researcher to demonstrate the existence of feedbacks and to reject model structures which imply no feedbacks from one endogenous variable to another. For instance, the estimates from this article imply that the farm level is not the center of price discovery in shortrun beef markets.

This research can be extended to alternative models of price discovery. No level has been eliminated as a center of price discovery in pork markets, and retail or wholesale levels are still candidates for beef markets.

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Agricultural Interest Rates and Inflationary Expectations: A Regional Analysis

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Abstract. *The Fisherian hypothesis was tested for four regional agricultural interest rates in the 11th Federal Reserve District (Dallas). These interest rates represented agricultural loans of different terms to maturity. Shocks in expected inflation resulted in positive but less than equivalent responses in all four rates. The empirical evidence from the impulse response function suggested that Fisher's relationship holds imperfectly for agricultural interest rates in the Dallas Federal Reserve District.*

Keywords. *Fisher's hypothesis, vector autoregression, cointegration, stationarity, impulse responses, agricultural interest rates.*

Fisher's theory stated that a one-for-one relationship exists between changes in nominal interest rates and changes in expected inflation (*8*).[1] We concentrate on the agricultural credit or interest rates of the 11th Federal Reserve District (the Dallas District) and employ cointegration tests and vector autoregression (VAR) econometrics to discern whether the Fisherian hypothesis holds, to reveal the degree or strength with which it holds, and to reveal evidence in the data concerning the dynamic patterns with which the relationship operates.

Theoretical Background

The Fisherian hypothesis:

$$r_n = E(r_r) + E(i) + [E(r_r)E(i)], \quad (1)$$

states that the nominal rate of interest r_n depends upon the expected real rate of return on assets $E(r_r)$ plus the expected inflation rate over the period of the loan E(i) plus their cross product. The expected real rate of return depends upon longrun factors such as productivity and thrift in the economy. In previous analyses, the cross product was considered insignificant, and $E(r_r)$ was considered constant over time. Thus, only changes in the inflationary forecast for the period of the loan would influence movements in the nominal rate of interest. Expectations of price inflation raise nominal rates by reducing lenders' willingness to lend and/or by increasing borrowers' willingness to borrow at given nominal yields (*9*). Fisher hypothesized this relationship between expected inflation (or the inflation rate) and nominal interest to be one-for-one. Equation 1 is not meant to represent a full and complete theory of interest rate determination, but seeks to quantify the effects of inflationary expectations on nominal interest rates (*11*).

At least three effects (the wealth, income, and depreciation tax effects) have since been advanced which suggest that real rates are inversely related to inflationary expectations. So, increases in nominal rates due to this inflation premium would be somewhat offset over time by the resulting decline in the expected real rate. An alternative view suggests that the income tax effect may create a greater than one-for-one response. It follows from these alternative theories that changes in inflationary expectations would have two separate temporal influences on nominal rates. The first would be an immediate, positive, and direct effect from the inflation shock on nominal rates. The second would come as a lagged, indirect, and uncertain effect upon the nominal rate through its influence on the expected real rate (*22*, *27*).

Review of the Literature

In Fisher's original test, long-term bond yields and 4- to 6-month prime commercial paper rates were tested against a weighted average of past rates of inflation (*8*). Fisher's results suggested that the response of nominal rates to a long history (up to 30 years) of inflationary expectations was less than one-for-one. However, price changes did affect interest rates in the direction indicated by Fisher's theory.

Sargent (*23*), using a dynamic linear macroeconomic model, said that an increase in expected inflation would eventually drive up nominal interest rates by an equivalent amount. These changes, however, would be distributed over long periods (up to 10 years or longer). He further stated that the higher the inflation rate, the shorter the period of adjustment.

Gibson (*11*) showed that adjustment of nominal rates to inflationary expectations had evolved toward unity from 1952 through 1965, especially for short-term rates. The post-1965 period gave evidence that rates had overadjusted. Treasury securities were used to eliminate the effects of changing default risk premiums. However, similar results were shown for a variety of risky market rates such as commercial paper and various corporate bonds.

Fama (*7*) tested how well information about future inflation was used in setting prices for 1- to 6-month U.S. Treasury bills (T-bills) during 1953-71. Based upon sample autocorrelations and regression estimates, Fama concluded that the markets were effi-

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[1]Italicized numbers in parentheses cite sources listed in the References section at the end of this article.

cient and that expected real returns were constant over time. He inferred that all variation through time in nominal rates mirrored the variance in the expected inflation rate.

Lahiri (*18*) combined information from observed price expectations (Livingstone data) with past rates of inflation in order to derive new estimated price expectation variables. Four different estimates of inflationary expectations were used to test Fisher's theory. These short-term expectations explained about 80 percent of the variation in nominal rates for 3-month T-bills.

Friedman (*9*) investigated the role of lenders' portfolio behavior in the relationship between price expectations and risky nominal interest rates. Simulation over six major lender categories showed that nominal long-term fixed-interest yields on corporate bonds rose by 0.65 percent for each 1-percent rise in expected inflation. This less than one-for-one adjustment occurred over a period of 4 years.

Urich and Wachtel (*29*) examined the effect of the announcements of both the consumer price index (CPI) and the producer price index (PPI) on 3-month T-bill rates. No effect of PPI during 1977-79 and CPI for 1977-82 was shown. An unanticipated increase of one standard deviation in PPI during 1979-82, however, yielded an 11.4-basis-point increase in nominal rates for 6- to 12-month maturities. Evidence of any lagged effects was very weak, suggesting new information was rapidly incorporated into market interest rates.

Data Series

We examine the probable relationship between inflationary expectations and four series of average nominal rates on new agricultural (farm) loans for the 11th District Federal Reserve Bank of Dallas. The Dallas District includes Texas, Oklahoma, New Mexico, and Louisiana. The four interest rates considered were: feeder cattle loans (RFC), other operating loans (ROO), intermediate-term nonreal estate loans (RIT), and long-term real estate loans (RLT). The quarterly interest rate survey data (for the third quarter of 1975 through the third quarter of 1989) was obtained from the Federal Reserve Board's *Agricultural Finance Databook*. The Federal Reserve Board surveys of interest rates were initiated in the third quarter of 1975.

Because Fisher's hypothesis relates nominal interest rates to expected rather than actual inflation rates, we must create a series of quarterly expected (or forecast) inflation rates. A naive forecast approach generates a time series of forecast CPI levels. We aim to model the expected inflation rate as the percentage change in forecasted CPI levels. (This article follows previously cited research (*9* and *29*) in using the Bureau of Labor Statistics' CPI series (all urban consumers, all items).)

Given a naive forecast approach, the "best" or "optimal" forecast for all future quarters' CPI levels is the present quarter's CPI. However, the present quarter's (t) CPI would not be fully known to borrowers and lenders when interest rates for quarter (t) are discovered. Hence, the previous quarter's (t–1) CPI is used as the present quarter's (t) forecast for all future levels of CPI. For example, the actual CPI for 1975:2 would be used as the 1975:3 forecast. The actual CPI for 1975:3 would be used as the 1975:4 forecast, and so on. In this manner, a series of forecast levels of CPI is generated for the 1975:3-1989:3 period.

Changes in a variable's natural logarithms approximate the proportional change in the (nonlogged) variable's levels. The forecast CPI levels were therefore transformed into their natural logarithmic counterparts. The logged forecast CPI series (CPIF) is then used in formulating the VAR model. The impulse responses of the CPIF series act as the proxy for changes in the expected rate of inflation. Because the impulse response function measures the responses of interest rates to a shock to the residual (or innovation) element of the CPIF series, the shock may be considered as equivalent to a change in the expected inflation rate. So the VAR system models CPI forecasts in natural logarithms, so that shocks to, or impulse responses in, this variable are equivalent to proportional changes in the nonlogged CPI forecasts, that is, expected inflation. (These proportional changes are converted to percent changes when multiplied by 100.)

Stationarity tests conducted on the CPIF levels (discussed below) support our decision to model the CPI forecasts (logged) as naive forecasts of the logged CPI levels. Results fail to reject the null hypothesis that CPIF, and hence the logged CPI levels, constitute a random walk at a 5-percent significance level.

Cointegration and Fisher's Relationship

Until recently, much of the literature's econometric work assumed that underlying economic series were stationary and ergodic, despite economic time series often being nonstationary (*15*, p. 201).

A stationary process is one in which the mean and variance do not change through time, and the covariance between values of the process at two points depends only on the distance between these time points and not on time itself. A time series is stationary when its generating mechanism is time-invariant, so that neither the form nor the parameter values change through time (*13*, *26*). If the generating process is linear, then the major properties of the process are captured in the mean and variance (*13*).

Yet much econometric research assumes that the underlying processes are stationary (*15*, *26*). When a series is not stationary, the statistical consequences

are onerous: regression estimates do not converge in probability with increased sample size; r-square values have nondegenerate distributions; and a divergence in t-value distributions often exists such that asymptotically correct critical values do not exist (*15*). Econometric estimates and their distributions are not guaranteed to have the desirable statistical properties when this assumption is violated (*15*).

Given a nonstationary series, univariate procedure, often extended to multivariate analysis, would require mathematically transforming (usually through first-order differencing) the data to a stationary series.[2] Yet, this approach of differencing nonstationary economic series into stationary series has been criticized by Hendry: "By analyzing only the differences in economic series, all information about potential (long-run) relationships between the levels of economic variables is lost; this seems a drastic 'solution'." (*15*, p. 204). Nerlove, Grether, and Carvalho (*20*) also reject stationarity-inducing transformations to let the nonstationarity in one series explain the nonstationarity in the other. On the one hand, statistical procedure requires stationary series, while economic time series with which one builds econometric and statistical models are often nonstationary (*15*). Otherwise, the mathematical data transformations that would induce stationarity, such as differencing, are criticized for throwing out and ignoring valuable longrun equilibrium information (*6*, *15*). Engle and Granger (*6*) said that modeling with differenced data can raise serious misspecification problems through the ignoring of theoretically relevant longrun components in the levels data.

The researcher can avoid the serious misspecification problems encountered by differencing data. Granger writes:

> "At the least sophisticated level of economic theory lies the belief that certain ... economic variables should not diverge from each other by too great an extent, at least in the long-run ... Such variables may drift apart in the short-run ... [but] then economic forces ... begin to bring them back together." (*12*, p. 213)

Fisher's equation relating the Dallas District credit rates and changes in the logged CPI forecasts (expected inflation) could be considered one of the forces which imposes longrun equilibrium relationships on the variables, shortrun divergences notwithstanding.

A set of variables is cointegrated when each variable is individually nonstationary in levels, and when the individually nonstationary variables form stationary linear combinations with the contemporaneous values of the other variables, that is, the resulting linear equation generates stationary residuals (*6*, *15*). The cointegrating restriction would be "Fisher's hypothesis," and is hereafter referred to as the "cointegrating restriction" or relationship (*8*). So, testing for the cointegrating relationship between forecast CPI and the four Dallas District interest rates requires two sets of stationarity tests: (1) on the data levels of each series, and (2) on the residuals of each cointegrating regression (CR), where each CR is one of the variables regressed against the contemporaneous values of the other four variables (*6*, *14*, *15*).

We followed the procedure of testing a time series for a unit root (for nonstationarity) developed by Dickey and Fuller (*2*, *4*), and augmented by Engle and Granger (*6*) (hereafter the augmented Dickey-Fuller or ADF test). One tests for nonstationarity by regressing the first differences of a variable (data levels or CR residuals) against a constant, a one-period lag of the nondifferenced variable, and a selected number of lagged dependent variables. We employed Hsiao's (*16*) lag selection procedure based on the criterion of minimized final prediction error to determine the number of lagged dependent variables to include in the ADF regressions. These ADF regressions provide what are called pseudo t-values on the nondifferenced lagged regressor, since they are calculated as, but not distributed as, a Student t-statistic (*6*, *14*). Critical values are published in Fuller (*10*), Dickey and Fuller (*3*), and Hall (*14*). One rejects the null hypothesis that a unit root exists (that the variable is nonstationary) when the calculated pseudo t-value is negative and of an absolute value in excess of that of the critical value.

The ADF test was performed on each variable's levels and on the residuals on each variable's CR or linear combination of the other variables. We also performed a second test, the "cointegrating regression Durbin-Watson" or CRDW test on the five sets of CR residuals (see *6*, *14*). For the CRDW test, one rejects the null hypothesis that the residual series is nonstationary when the CR equation's Durbin-Watson value exceeds the critical value. Hall (*14*) has published critical CRDW values.

Table 1 shows the ADF pseudo t-values for the data levels, the ADF pseudo t-values for the CR residuals, and the Durbin-Watson values for the residuals of the cointegrating regressions. While each of section I's pseudo t-values are negative, all have an absolute value of less than that of the ADF critical value of –2.89 at the 5-percent significance level (*10*, p. 373). So, evidence at the 5-percent significance level is insufficient to reject the null hypothesis of nonstationary levels of all five modeled variables. Evidence suggests that the five modeled variables are individually nonstationary.

[2]Differencing removes one order of integratedness from the data, and the order of integratedness is the number of times the data must be differenced for the series to be stationary. For example, a series that is integrated of order one, I(1), must be differenced once to transform the series into a stationary one, denoted an I(0) series.

Table 1—Stationarity test results on the series levels and on the cointegrating regression (CR) residuals

Test	CPIF	RFC	ROO	RIT	RLT
I. Levels, ADF:[1]	−2.19	−2.11	−2.09	−2.04	−2.16
II. CR residuals:					
a. ADF:[2]	−1.72 (−5.50)[4]	−5.96	−4.70	−4.90	−5.12
b. CRDW:[3]	1.42	2.60	2.45	1.68	1.61

[1]The ADF critical value at the 5-percent significance level is −2.89 (*9*, p. 373). One rejects the null hypothesis of a unit root (random walk or nonstationarity) when the calculated pseudo t-value is negative and has an absolute value in excess of that of the critical value.

[2]The ADF critical value for a three-variable case at the 5-percent significance level is −3.13 (*13*). At this writing, the critical values for a five-variable case were not located in published form. We followed Hall and applied this critical value for the three-variable case to a five-variable case with caution. One rejects the null hypothesis when the pseudo t-value is negative and has an absolute value in excess of the critical value.

[3]Hall reports the CR Durbin-Watson test critical value to be 0.367 for a 3-variable case at the 5-percent significance level (*13*). One rejects the null hypothesis of nonstationary residuals when a cointegrating regression's Durbin-Watson value exceeds the critical value. Following Hall, we applied this critical value for the 3-variable case to a 5-variable case with caution (see *13*).

[4]Evidence of nonstationarity of CR residuals is more ambiguous for CPIF than with the other four variables, although, on balance, the results generally point to stationarity. The CR pseudo t-value of −1.72 for the ADF test fails to reject the null hypothesis of nonstationarity, and because this value contradicted the CRDW result which suggests stationarity at the 5-percent significance level, we provided the Dickey-Fuller, or DF, test (as opposed to the ADF test) for additional evidence. This −5.50 value suggests that evidence is sufficient to reject the null of nonstationarity at the 5-percent significance level when Fuller's (*9*) critical value of −2.89 is used, and is adequate to reject the null when Hall's DF critical value of −3.37 is used. (Hall reported DF critical values only for the 2-variable case.) So, despite the ADF pseudo t-value being insufficient to reject the null hypothesis of nonstationary CR residuals for CPIF, we feel that on balance, evidence suggests stationarity because both the CRDW and DF tests suggest stationarity at the 5-percent significance level.

In section II, ADF results suggest that evidence is adequate to reject the null hypothesis of nonstationary CR residuals, and to accept the alternative hypothesis of stationarity in all but one case (CPIF) at the 5-percent level. Note, however, that the additional evidence and footnotes in table 1 reveal considerable evidence that CR residuals for CPIF are also stationary. CRDW results suggest that evidence is sufficient to reject the null hypothesis of nonstationary CR residuals for all five cases at the 5-percent significance level. So, on balance, the combined results suggest that the residuals of all five cointegrating regressions are stationary. Evidence suggests that the logged forecast CPI values and the four agricultural interest rates for the Dallas District are cointegrated with Fisher's relationship (equation 1).

Model Selection Criteria and Model Choice

Sims (*24*, p. 489) has recently noted that economists are confronted with the situation experienced by natural scientists of having an expanding array of analytical tools at our disposal. Meaningful modeling efforts constitute a wide spectrum, from purely theoretical models with no connection to observed data to purely data-oriented statistical models with little connection to theory (*24*, p. 489). The latter category includes data-oriented vector autoregression (VAR) models with few *a priori* theoretical restrictions. Midway between such efforts would be "structural time series" efforts such as the "cointegration" (vector error corrections or VEC) models of Robertson and Orden (*21*) who combine time-series or VAR methods with a more intensive use of theory. Sims notes that all of these models have valid uses, that no one model type is "right" or "wrong" in an absolute sense, and that economists should not waste energy in fruitless debate over which modeling style is universally correct. Rather, the researcher decides on an appropriate modeling style after careful consideration of the following criteria: (a) the desired degree of connection to the data, (b) the desired intensity with which theory is used, (c) the desired confidence levels with which one invokes and tests hypotheses with inference, (d) the degree to which the chosen model facilitates the analytical purpose, and (e) how well the model predicts beyond the information set (*24*). Sims sees that no existing model can be expected to perfectly meet all of these criteria, and that all existing models are compromises concerning the fulfillment of these criteria.

The five modeled variables are cointegrated. And Engle and Granger (*6*) and Campbell and Shiller (*2*) show how one should use "cointegration" models—vector error correction (VEC) models—to effect certain goals of analysis. A VEC framework accounts for the longrun cointegrating relationships through the use of levels-based error correction terms reflecting how far the cointegrated system has been from the longrun equilibrium in the shortrun (*6*, *21*). A VEC model would be appropriate when the researcher (1) is required to work with differenced data and needs to mitigate misspecification problems through the inclusion of levels-based error correction terms, (2) wants to make longrun forecasts beyond the sample, and (3) wants maximal estimate efficiency to conduct reliable inference about the theoretically based parameter estimates. Our analytical purpose does not include these three analytical purposes. Engle and Granger (*6*) acknowledge that other modeling efforts along the Sims spectrum, say a VAR model in nondifferenced levels with large samples, successfully capture the cointegrating relationships such as Fisher's equation 1 in our Dallas District data. Sims suggests that analytical purpose and other selection criteria should determine whether a VEC or a VAR model in levels would be appropriate. The researcher is not mandated to build a VEC model simply because there is cointegration. Our analytical purpose favors a VAR in levels with maximal observation numbers.

Our analytical purpose is twofold. We first test the CPIF, RFC, ROO, RIT, and RLT data levels for the existence of Fisher's longrun cointegrating relationship. Second, we test the data levels (with Fisher's cointegrating relationship embodied) for evidence concerning how perfectly and with what dynamic patterns the cointegrating relationship has held in the Dallas District. We have chosen a VAR model in levels, rather than a VEC model restricted for Fisher's relationship. We chose the VAR model in levels over the VEC model because one should not restrict a model for the very theoretical restriction that the model is being used to test the data for (see *1*). A VEC model is inappropriate for our analytical purpose because it uses error correction terms to restrict the model for the very restriction we are testing the data for. We follow Sims' model selection procedure because our criterion (d) or analytical purpose requires an emphasis of criterion (a) or data connections at the expense of criterion (b) or intensity of theory usage. Testing data for a theory—here, for Fisher's relationship in the Dallas District's agricultural credit markets—often "requires fitting ... models ... to view the dynamic system with as few *a priori* restrictions as possible, allowing what regularities that are present in the data to reveal themselves." (*1*, p. 111)

Estimated VAR Model

VAR econometrics involves a multivariate system in which each of the system's variables is allowed to influence every other variable in the system with lags. VAR methods allow characterizing a dynamic system without forcing particular *a priori* (theoretical) interactions within the variable set. The method may be considered as the first step in describing the average behavior concerning Fisher's hypothesis for Dallas District agricultural credit rates over the observation period (*1*). We do not develop the VAR econometric method here. Interested readers should consult Sims (*25*) and Bessler (*1*). We proceed directly to the estimated VAR model.

The following VAR model was estimated during 1977:1-1989:3:

$$
\begin{aligned}
X_t = {} & a_{X,0} + a_{X,T}{*}TRD + a_{X,1}{*}CPIF_{t-1} + \ldots. \\
& + a_{X,3}{*}CPIF_{t-3} + a_{X,4}{*}RFC_{t-1} + \ldots. \\
& + a_{X,6}{*}RFC_{t-3} + a_{X,7}{*}ROO_{t-1} + \ldots. \\
& + a_{X,9}{*}ROO_{t-3} + a_{X,10}{*}RIT_{t-1} + \ldots. \\
& + a_{X,12}{*}RIT_{t-3} + a_{X,13}{*}RLT_{t-1} + \ldots. \\
& + a_{X,15}{*}RLT_{t-3} + e_{X,t}, \qquad (2)
\end{aligned}
$$

where X = CPIF, RFC, ROO, RIT, RLT, the first right-side regressor represents an intercept, and all a-coefficients are regression coefficients. TRD is a time trend variable and $e_{X,t}$ represents X's stochastic error or innovation in period (quarter) t. The five equations, of equation 2's form, represent the five modeled variables.

Tiao and Box's (*28*) method of lag selection was chosen to obtain a lag structure large enough to approximate white noise but small enough to be operational. The Tiao-Box likelihood ratio tests, conducted at Lutkepohl's (*19*) suggested 1-percent significance level, implied a 3-order lag for the VAR. Observations during 1975:3-76:4 were saved for the lag search, leaving the 1977:1-89:3 observations for the estimation period. Coefficients were estimated for the VAR using ordinary least squares. Doan and Litterman's (*5*) package, Regression Analysis of Time Series (RATS), generated all results.

Doan and Litterman (*5*) have programmed the Ljung-Box Q-statistic into RATS. Distributed as a chi-squared distribution, the Q-value tests the null hypothesis of white noise innovations, that is, the hypothesis of an adequate model. The five equations' Q-values fell within the 19.5-27.3 range, less than the critical value of 38.9 (1-percent significance level). For all five equations, evidence was insufficient to reject the null hypothesis that innovations constitute a white noise process, leading to the conclusion that evidence fails to reject the hypothesized adequacy of the estimated VAR model equations (*13*, pp. 99-100).[3]

The equations of the VAR may have contemporaneously correlated innovations. Failure to correct for contemporaneous correlation between the equations' errors will produce responses not representative of historical patterns (*25*). A Choleski decomposition was imposed on each VAR to orthogonalize the current innovation matrix, such that the covariance matrix of the modeled innovations is identity. The Choleski decomposition resolves the problem of contemporaneous feedback.

The Choleski decomposition requires a sometimes arbitrary imposition of a Wold causal ordering among the current values of the dependent variables (*1*). A VAR ordering usually begins with the shock variable, and then proceeds on the *a priori* belief of the

[3]Evidence suggests that the estimated VAR model is stationary. We performed the augmented Dickey-Fuller (ADF) test on the residuals of each of the VAR model's five estimated regressions. Hsiao's (*16*) criterion of minimized final prediction error was chosen to determine the number of lagged regressors. All five pseudo t-values fell within the –5.5 to –4.7 range. At the 5-percent significance level, Fuller (*10*, p. 373) reports a –2.89 critical value. A VAR regression resembles a cointegrating regression in certain ways, and if the researcher deems the VAR equations to be enough like CR equations, then the researchers might decide to use Hall's (*14*) critical value for the 3-variable case of –3.13 (5-percent significance level). Little practical consequence arises from choosing among these two critical values, insofar as they are both of similar magnitudes. With either the Fuller or Hall critical values, evidence is sufficient at the 5-percent level to reject the null hypothesis of nonstationarity. Evidence suggests that the residuals are stationary in all five cases. The estimated VAR model appears stationary.

sequence in time over which the different variables will respond to the initial shock. No *a priori* belief held that any of the four interest rates should precede the others in responding to changes in inflationary expectations. The VAR model was therefore ordered (following CPIF) on the basis of term-to-maturity of the loan series. Thus, the series were ordered as CPIF, RFC, ROO, RIT, and then RLT. Other orderings were possible, but were not considered.

The impulse response function is a technical operation performed on an estimated VAR. The impulse response function simulates over time the effect of a typically sized shock in one series on itself and on other series in the system. Calculating impulse responses provides the dynamics of how variables in the modeled system respond to the imposed one-time shock. The estimated VAR model (equation 2) was shocked with a one-time increase in CPIF, and this shock represents a rise in expected inflation. Following standard procedure, the typically sized shock was a one-standard-error increase in the variable's historical innovation. This shock amounted to a 0.25-percent, or 25-basis-point, rise in forecast CPI.

Kloek and van Dijk's Monte Carlo method (*17*) provided a t-value for each impulse response. The t-value tests the null hypothesis of a nonzero impulse value at the chosen (here, 5-percent) significance level. Significantly nonzero responses were the ones that were emphasized.

We examined the impulse responses in the four agricultural interest rate variables (RFC, ROO, RIT, and RLT). The dynamic patterns of the impulse responses included: the "reaction" times required for each variable to respond to the shock in expected inflation, the directions and patterns of each variable's impulse responses, and the durations of the variable's impulse responses. How the interest rate responses contrast in magnitude to the size of the impulses of the proxy for expected inflation is particularly important to the Fisherian hypothesis. These dynamic results from the impulse response function provide the very information needed to discern the strength and dynamic patterns with which Fisher's relationship has historically operated in the Dallas District's agricultural credit markets.

Responses to a Shock in Expected Inflation

Table 2 provides the responses over time for the five series that were subjected to a one-time shock (of 0.25 percent, 25 basis points) in CPIF. The four interest rate responses were statistically significant at the 5-percent significance level in the first period and statistically insignificant thereafter.

In the first period following the shock, feeder cattle loans (RFC) and intermediate-term, nonreal estate loan rates (RIT) increased 15 basis points (0.15 percent), or 60 percent of the initial increase in CPIF. Other operating loan rates (ROO) increased almost 16 basis points, 64 percent of the shock to CPIF. Long-term real estate loan rates (RLT) increased 20 basis points, 80 percent of the initial shock in CPIF.

Table 2—Impulse responses in CPIF and agricultural interest rates resulting from a shock in CPIF

Period	CPIF[1]	RFC[2]	ROO[3]	RIT[4]	RLT[5]
1	0.25*	0.15*	0.16*	0.15*	0.20*
2	.31*	−.16	−.14	−.14	−.08
3	.29*	−.01	−.02	0	−.02
4	.43*	.17	.15	.14	.08
5	.55*	.04	.04	.04	.01
6	.60*	.18	.17	.16	.14
7	.68*	.34	.33	.30	.27
8	.75*	.34	.34	.32	.29
9	.76*	.39	.39	.37	.36

*Statistically significant at the 5-percent level of significance.
[1]Forecasted logged values of the quarterly Consumer Price Index, whose impulse responses act as a proxy for changes in expected inflation. The impulses were multiplied by 100 for conversion into basis points in this table.
[2]Quarterly, nominal interest rates for feeder cattle loans for the Dallas District.
[3]Quarterly, nominal interest rates for other operating loans for the Dallas District.
[4]Quarterly, nominal interest rates for intermediate-term, nonreal estate loans for the Dallas District.
[5]Quarterly, nominal interest rates on long-term real estate loans for the Dallas District.

All four rate series showed a significant positive association with CPIF. The change in the four rates was less than the initial shock in CPIF, which suggests the degree to which (that is, how perfectly) Fisher's relationship holds in the Dallas District for agricultural interest rates. The interest rate responses were immediate, occurring in the same quarter as the initial shock, and had no significant effects thereafter.

A possible reason for the less-than-equivalent responses in nominal interest rates may be that the income, wealth, and depreciation tax effects dominate any income tax effects. Given an increase in inflationary expectations, expected real rates respond inversely to the initial inflationary shock, offsetting the initial response of the nominal rates.

The magnitude of the results for the agricultural loans is similar to that found by previous research for government and corporate bond markets. This suggests that the presence of any additional risk (whether in corporate or farm loan rates), while increasing the magnitude of the levels of nominal rates with respect to the levels of risk-free loan rates, does not appear to affect the relationship between changes in inflationary expectations and changes in nominal interest rates.

Conclusions

The empirical evidence suggests that Fisher's hypothesis holds, albeit imperfectly, for agricultural interest

rates in the Dallas District. A rise in inflationary expectations resulted in less than a one-for-one change in all four series of farm loan rates. The effect was positive, as Fisher's theory and most previous research had indicated. Nominal rates rose, on average, by 66 percent of the increase in expected inflation, very close to Friedman's estimate (65 percent) for corporate bond yields. The changes in short-term rates of 15 and 16 basis points given a standard error change in CPIF, closely approximates Urich and Wachtel's estimate from a standard error change in PPI. We concur with Urich and Wachtel, unlike Friedman and Sargent, in that inflationary effects were incorporated immediately, and without lag, into nominal rates.

That agricultural interest rates rise by only about two-thirds of the perceived increase in inflation in the Dallas District, and that individual interest rate responses vary according to the farm loan's term-to-maturity, are policy-relevant results. Such results can be of interest to policymakers involved in the formulation of certain kinds of agricultural credit policy. Suppose, for example, that policymakers were to consider compensating certain financially stressed farmers for increased inflation through interest rate subsidies (write-downs) on farm loans, and that the write-down's cost (size) was a concern. Our results suggest that write-downs granted to farmers in and around the Dallas District need not meet recent CPI increases on a percent-by-percent basis, because the area's credit rate responses to inflationary expectations have been historically less. Our results further suggest that the size of any such write-down may vary with the terms-to-maturity of the farm loan types. Note that our results are relevant to the Dallas District, and should not be generalized to the agricultural credit markets of other (or broader) areas. Similar analyses are needed for the agricultural credit rates of other Federal Reserve districts.

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Free Trade and Agricultural Diversification, Canada and the United States. *Edited by Andrew Schmitz. Boulder, CO: Westview Press, 1989, 368 pages, $42.50.*

Reviewed by Carol Goodloe

Well, here it is, another anthology. Skimming over the book review sections of agricultural economics journals reveals that the profession is currently besieged (plagued?) with a plethora of anthologies emanating from numerous conferences, special studies, and research symposia.

The chapters of *Free Trade* cover many topics: U.S.-Canada trade issues, irrigation technology, value-added activities, U.S. farm programs, Canadian agricultural subsidies. Because of the variety and lack of integration of articles, the title of the book is misleading. Some articles never mention the U.S.-Canada Free Trade Agreement (FTA) or directly address the theme of the book. Only chapter 3 clearly links the FTA and agricultural diversification. It is hard to imagine any one reader who would be interested in, or have the background to benefit from, all the topics.

The book's stated subject is the diversification of prairie (western Canadian) agriculture and how it has been affected by agricultural policies, including the FTA. The book is part of a larger research effort undertaken by the Research Council of Canada on the future of the prairie grain economy. Other books have already been published on the research. The editor has, according to the preface, added several articles (chapters 5, 7, 9) not directly connected with the research project to add parallel information on the United States.

In a good anthology, the sum of the knowledge and information from the pieces should add up to a well-integrated whole. The individual articles should be focused on a theme or problem, accompanied by a summary article that integrates the evidence and conclusions. After digesting the summary, the reader should come away with the main points of the book, referring to the individual articles for more detailed information and arguments. I recently read an anthology that met these criteria—*Free Trade Areas and U.S. Trade Policy*, edited by Jeffrey J. Schott.

Regardless of the merits of any one article in *Free Trade*—and several were well written and personally of interest—I came away feeling that the sum of the pieces was less than one. Most articles overstate the role and impact of the FTA on North American agriculture. The agricultural provisions in the FTA were very specific and limited to a few commodities, with the exception of overall, staged tariff reductions. Inaccuracies in several chapters suggest some authors are not fully versed in the agricultural provisions of the FTA.

Chapter 6 assumes the FTA will lead to a reduction or elimination of agricultural subsidies (pp. 188, 216). If the reader looks at the content of the agreement, this assumption is inaccurate. The FTA will lead to modest reductions in trade barriers. Only one paragraph in one Article of the FTA (701, 5) directly removes an agricultural subsidy. Linking the FTA to changes in agricultural diversification through subsidy reduction goes unsupported.

Another article claims "both the FTA and potential agreements arising from the current Uruguay Round of the GATT threaten to reduce the role of farm programs in the United States" (p. 303). Although Article 701 of the FTA states that the goal of both countries is "to achieve, on a global basis, the elimination of all subsidies which distort agricultural trade," the limited provisions of the FTA cannot be expected to achieve this result. Whether such a result will spring from the Uruguay Round (a doubtful prospect) is another question.

The editor writes in the preface that an attempt was made to write articles accessible to the general public by deleting mathematics and highly theoretical treatments. Although most articles were not highly technical, the narrowness of the subject material limits the readership. Chapters 3, 8, and 9 relied heavily on model specification, equations, and statistical jargon. (Economists don't like to state their results without explaining in great detail how they got there.) I doubt that the Herfindahl index, variance/covariance matrix, correlation matrix, mean-standard deviation tradeoff, and capital asset pricing model are part of the general public's vocabulary. The general public's response to these chapters will be to put the book back on the shelf.

Another gripe is the editing. I don't know who gets the blame, the editor or the publisher, but somebody should 'fess up. I have reconciled myself to the fact that many economists have only a passing interest in the English language, but surely better proofreading would have caught the more egregious errors. My favorite typo was in a reference to "effects of beef trade *liquidization* in Japan" (p. 134). I assume the author meant *liberalization*. My irritation reached a

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new high when, after reading two poorly edited chapters on irrigation, I came across this sentence, "Thus, the results of scenario A serve to explain the use of furrow *irritation* with cotton production ..." (p. 234).

After sounding like a combination of the Grinch and Scrooge, can I find something positive to say about this book? Because of my professional interests in Canadian agriculture and the FTA, I found chapters 2, 3, 4, 5, and 10 worthwhile reading. People with similar interests would likely reach the same conclusion. At first, little seemed to connect the title of chapter 2 ("Agricultural Diversification Strategies: Canada and the United States") and the stated purpose of the article—"to discuss border disputes between the U.S. and Canada in the context of GATT" (p. 8). But, the article ultimately joined the two ideas by offering guidelines on how the Canadian Government could allocate funds to promote agricultural diversification without getting ensnarled in U.S. countervailing duty laws, a major concern for Canadian agricultural policy.

Chapter 3 presented clear, solid analysis of the effect of different trade scenarios on agricultural diversification. Chapter 8 used financial management theory to provide analysis of farm enterprise size and diversification. Being ignorant about this area, I don't know if this analysis is novel, but the results were informative. The analysis in chapter 10 provided insights into how the East-West split in Canadian agriculture affects policy formulation and other factors.

Chapters 4 and 5 presented an excellent overview and analysis of food-processing industries and value-added activities in Canada, an area that could benefit from further such efforts. However, I was bothered by two contradictory statements on the first page of chapter 5. First, the authors "argue in this chapter that both industries [brewing and flour milling] will be significantly altered because of the FTA." Four sentences later, they opine, "Although the brewing industry was left out of the FTA, market forces continue to push the industry toward freer trade" (p. 139). The authors provide a sound explanation of why the brewing industry was left out of the FTA, but fail to explain how the industry will be altered, even indirectly, by the FTA.

Despite different definitions and measurement techniques, the authors' conclusions about agricultural diversification generally agreed: crop farmers who diversified into other crops or livestock saw few economic gains. Diversification strategies should include off-farm employment and investments in financial instruments as options.

One recent reviewer in this journal recommended that potential readers of a certain book (yes, an anthology of conference papers) save their dollars and head for the library, citing "lack of integration, continuity, synthesis, and critical contrast" (Blakeslee, Vol. 41, No. 4, Fall 1989). I can only concur with his conclusion. My suspicion is that, as a result of the bureaucratization of academia (see *The Last Intellectuals* by Russell Jacoby), one gets more chits for quantity than quality; the rewards are greater for presenting three conference papers in 1 year (and later having them published in a "proceedings" that ends up collecting dust on bookshelves) rather than spending 3 years researching answers to tough, novel, and relevant questions. An increasing number of anthologies are elbowing aside book-length treatments of research topics. Schmitz's *Free Trade* might be worth a trip to the library to spend an hour or so with a couple of articles, but I can't imagine who would check it out for the whole 3-week lending period. The articles are just too scattershot and unconnected to recommend that anyone read, much less buy, the whole book.

The papers include: (1) "Introduction" by Andrew Schmitz; (2) "Agricultural Diversification Strategies: Canada and the United States" by Andrew Schmitz; (3) "Diversification of Prairie Agriculture" by William A. Kerr; (4) "Growth and Development of Value-Added Activities" by K.K. Klein and L. Chase-Wilde; (5) "Freer Trade in the North American Beer and Flour Markets" by Colin Carter, Jeffrey Karrenbrock, and William Wilson; (6) "Irrigation and Prairie Agricultural Development" by Surendra N. Kulshreshtha; (7) "The Adoption of Modern Irrigation Technologies in the United States" by Gary Casterline, Ariel Dinar, and David Zilberman; (8) "Farm Enterprise Size and Diversification in Prairie Agriculture" by William J. Brown; (9) "The Effect of U.S. Farm Programs on Diversification" by Richard E. Just and Andrew Schmitz; (10) "Agricultural Subsidies in Canada: Explicit and Implicit" by W.H. Furtan, M.E. Fulton, and K.A. Rosaasen.

International Financial Markets and Agricultural Trade. *Edited by Thomas Grennes. Boulder, CO: Westview Press, 1990, 306 pages, $38.50.*

Reviewed by David Stallings

International Financial Markets and Agricultural Trade is the latest compendium of papers from the International Agricultural Trade Research Consortium, held in San Antonio, Texas, in December 1988. Readers hoping to find definitive answers to international macroeconomic questions are unlikely to be satisfied with this book. One may even ask where, exactly, definitive answers in the subject area can be found. The book, nonetheless, presents interesting and informative pieces in selected areas.

Thomas Grennes opens the discussion usefully by describing how the various chapters fit together. The problems of defining equilibrium exchange rates, according to Grennes, revolve around the failure of purchasing power parity (PPP) explanations of exchange rate movements. PPP, in its various forms, states (roughly) that exchange rates should adjust to offset changes in prices, price levels, or expected prices. Despite the failure of PPP models to explain observed movements in exchange rates, no alternative theory of an equilibrium exchange rate has taken its place. This is a serious theoretical problem. Without some plausible notion of an equilibrium value, efficiency in foreign currency markets will be difficult to observe.

Lawrence Officer attempts to integrate two strands of PPP theory, sometimes called the Law of One Price (LOP), that have stood alone, one at the disaggregate (commodity) level and one at the aggregate level. The idea is to use explanations for the deviations in PPP at the disaggregate level to explain those at the GDP level. There is considerable discussion of the use and calculation of the absolute form of PPP, using data from the United Nations international comparison program (ICP). Officer provides a very long, and useful, list of reasons as to why PPP may not hold. First, the costs of risk and transportation may insert a wedge between home and foreign prices. Second, trade restrictions exist. Third, there may be collusion. Fourth, we have product differentiation. Fifth, some commodity markets may exhibit inefficiency in the sense that not all arbitrage opportunities are exploited. Sixth, there may be measurement problems. A seventh reason, not mentioned by Officer, are the costs of *ex ante* and *ex post* contracting (in the spirit of Williamson, 1983).

This discussion by Officer leads into his survey of the wide variety of empirical studies that have been made since 1970 concerning the LOP. The preponderance of the evidence is that LOP does not hold. However, given the litany of reasons as to why it may not hold, one may wonder why the LOP is ever valid. Officer tests the LOP over a variety of aggregate agricultural commodity groups, such as bread and cereals, meat, fish, and tobacco. He uses the real price level (RPL), which is the absolute PPP converted to a numeraire currency. There is greater support for LOP at this disaggregate level in industrial countries than worldwide, but deviations from PPP are still severe. These results were extended to aggregate PPP measures. The central finding is much the same: PPP holds more closely in countries with similar (high) levels of development. The use of ICP data made both disaggregate and aggregate comparisons easier. ICP data permitted the use of consistent data set, which was hampered by single-year analysis with a limited number of countries.

Catherine Mann provides a discussion of Officer's material. She begins by placing Officer's definitions in a standard framework. She then demonstrates how Officer's tests of PPP are little different from those he had cited as flawed. Mann suggests that Officer's results at the aggregate level imply further testing for the importance of the tradable-nontradable goods breakdown in determining the proper role for differences in OECD and other economies. Her comments, while shedding light on the difficulties of explaining deviations from the law of one price, support Officer's explanation of deviation by integrating aggregate and disaggregate approaches.

Sebastian Edwards first defines the real exchange rate as the relative price of tradable and nontradable goods. He explains that this "captures the degree of competitiveness (or profitability) of the tradable goods sector in the domestic country." A longrun equilibrium rate, using this definition, is one that produces internal balance (expenditure equals income, and unemployment is at the "natural" rate) and external balance (longrun capital flows are consistent with the current account balance, implying there can be longrun capital inflows or outflows). This rate, of course, fluctuates with changes in trade controls, capital flows, terms of trade, and expected changes in any of these variables. Edwards begins with a very unrealistic model (perfect competition, nondistortionary taxes, a binding government budget constraint). The result is a definable equilibrium path for the real exchange rate. Edwards continues, then, by stating the obvious: no such real world exists. There must be some dynamic characteristics that produce "misalignments." They are, he argues, generally the result of macroeconomic policies

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which are inappropriate to the exchange rate regime. The most common is an expansive monetary policy under fixed exchange rates. Edwards calculates a variety of exchange rates, incorporating a useful discussion of the merits of each. These include bilateral and multilateral rates, and a few based on parallel, as opposed to official, rates. Edwards concludes by looking at the effects of exchange rate volatility on trade and economic growth. His estimates confirm the results obtained by the International Monetary Fund (IMF) and others that variability in the exchange rates of developing countries tends to adversely affect economic growth but not trade. He fails to point out, however, that the domestic policies that result in exchange rate variability may be the proximate cause of poor economic performance. Exchange rate misalignment is only a symptom, not the disease.

Barry Goodwin sets out the important reason that we depend on the law of one price: it is a necessary component of all theories of international trade and an important aspect of international monetary theories as well. He notes, as did Officer, that the vast weight of empirical evidence is against acceptance of LOP. Goodwin argues that LOP depends on contemporaneous prices. There is no consideration of expected changes in prices between the time of sale and delivery. Goodwin sets out a rational expectations model to narrow deviations from LOP for a selected set of U.S. agricultural export commodities: wheat and oilseeds. Here, with all prices in dollars, is the easiest test. He finds that an expectations-oriented model, which includes expected prices for a 2-month delivery, supports the LOP in 8 of 15 cases. This is a strong improvement over the "standard" model in which the LOP is supported in only two of the cases. A last test used by Goodwin adds proxies for transport and transactions costs, including a variable discount factor, to his original expectations model. The results confirm the validity of LOP in 13 of his original 15 cases. The clear implication is that the lack of the use of expectations is one major reason for the previous failure of LOP models.

Paul O'Mara opens with a discussion of the aggregate economic situation in Australia as of late 1988. Some parallels exist between the Australia of the mid-1980's and the United States of the late 1980's. Both have had large current account deficits, and both have had extended exchange rate depreciations which have had little effect on those deficits. O'Mara follows the traditional "Australian" approach to exchange rate determination in formulating his discussion for Australia. This approach, based on the Swan-Salter paradigm, states that the real exchange rate changes not to equilibrate external accounts but to assure that nontradable goods markets are in equilibrium. Other Australians, such as Max Corden (1986), continue to emphasize this approach. O'Mara effectively summarizes the research in the area done by the Australian Bureau of Agricultural and Resource Economics (ABARE). Medium-term forecasts using a general equilibrium model, judged equivalent to testing Swan-Salter, were compared with estimates based on a more standard approach emphasizing external accounts. The results were a strong confirmation of the Swan-Salter model. In the short term, however, movement in exchange rates may be dominated by overshooting or "rational speculative bubbles." ABARE research has demonstrated that a rise in the risk premium can also affect shortrun exchange rate movements. The debate on what forms a medium- to long-term equilibrium real exchange rate is really central to the future of international macroeconomics. O'Mara's discussion is brief but clear.

Douglas Pearce concerns himself with the economic performance of the foreign exchange market in terms of efficiency. He includes definitions of efficiency that are based on standard asset market models. Exchange rates, like other assets, are normally assumed to reflect some set of "fundamentals." Thus, efficient use of information would mean that models incorporating these fundamentals are used in determining foreign currency positions. Yet, views differ on both the composition and the effects of "fundamentals," such as money supply growth, on the economy at large, and therefore on exchange rates. Pearce surveys very well a number of efficiency tests. The most straightforward, whether the forward rate is a good predictor of the future spot rate, given rational expectations, has been rejected so many times as to make its viability nearly zero. Instead, numerous tests, under a variety of specifications, indicate that the forward rate is a biased predictor of the future spot rate, demonstrating only one of several ways that the empirical results of exchange rate models differ considerably from asset models based on, for example, stock prices. This bias, according to Pearce, does not denote inefficiency if there is a time-varying risk premium. Results from survey data indicate that the assumption of rational expectations is not necessarily robust. Incorporating "news" improves the information base somewhat, giving greater support to market efficiency models. Pearce then moves on to explore "speculative bubbles," a phenomenon that occurs during an appreciation when, for example, the forward rate underpredicts the actual spot rate, but the subjective probability by agents in the market is for the appreciation to continue (perhaps influenced by univariate time-series models). Both the "bubbles" and the uncertainty with which agents view model parameters can, according to Pearce, account for the observed failure of efficiency hypotheses.

John Kitchen makes some telling points in his comments on Pearce, concentrating on that author's omissions. Pearce, for example, does not discuss the relation of exchange rate volatility to international trade. Increasing exchange rate volatility, according to Kitchen's sources, lowers the volume of international trade, perhaps most especially agricultural

trade. Second, the results obtained by Pearce cast some doubts on the use of hedging by some agents to minimize risk. The observation that expected exchange rates and forward exchange rates are biased estimators implies that hedging operations impose unnecessary losses. Kitchen points out correctly that his is true only of those "continuously" in the market. Intermittent participants still gain from the use of hedging.

The most interesting point made by Kitchen, however, is both subtle and basic. There is no model that explains exchange rate behavior, because the fundamental determinants are either unknown or affect exchange rates in different ways at different times. Kitchen then takes models for commodity prices that are essentially the same as those specified by Pearce for exchange rates, asking whether or not forward prices are unbiased estimators of future spot prices. Several "news" variables for commodity prices (such as weather) are included. Forward prices are excellent, unbiased estimators of future spot prices for the commodities tested. Perhaps forward exchange rates are unbiased predictors of future spot rates, but we simply do not know what else to include in the function.

Douglas Purvis briefly discusses the evolution of the twin deficits in the United States, beginning with the monetary contracting of 1979-80. He argues that the tax cuts of 1981-83 provided the impetus for the continued appreciation of the dollar. The fiscal deficit, combined with a restrictive monetary policy, induced the capital inflows that sustained the large current account deficit. In his view, the forced responses of other countries to U.S. action were entirely passive. International capital flows allowed the U.S. fiscal deficit to be "exported." For example, high U.S. interest rates led to an appreciation of the dollar. The inflationary pressure in Europe, combined with fixed real wages, induced an increase in unemployment. Purvis describes this as a U.S. "beggar-thy-neighbor policy."

Purvis notes that while popular simple models (Mundell-Fleming) explain why a fiscal deficit can produce exchange rate appreciations, they do not explain well why they may produce depreciations. He goes on to cite portfolio-balance models that do better in confirming this phenomenon. One model implies that the United States may be tempted to extract wealth from foreign bondholders by devaluation or a tax on bonds. Thus, a fiscal deficit that must be financed by future tax revenues will result in immediate devaluation. The essential point, however, is that, as argued by O'Mara, the external deficit will not respond to exchange rate changes, only a reduction in the budget deficit. The key to the solution of the twin deficits, according to Purvis, is in raising the aggregate U.S. savings rate.

The papers include: (1) "The Link Between Financial Markets and World Agricultural Trade" by Thomas Grennes; (2) "The Law of One Price: Two Levels of Aggregation" by Lawrence H. Officer; (3) "Comments on 'The Law of One Price: Two Levels of Aggregation' " by Catherine L. Mann; (4) "Real Exchange Rates in Developing Countries: Concepts and Measurement" by Sebastian Edwards; (5) "Empirically Testing the Law of One Price in International Commodity Markets: A Rational Expectations Approach" by Barry K. Goodwin; (6) "Exchange Rates, Interest Rates, and Agriculture: A Macroeconomic View from Down Under" by L. Paul O'Mara; (7) "Information, Expectations, and Foreign Exchange Market Efficiency" by Douglas K. Pearce; (8) "Comments on 'Information, Expectations, and Foreign Exchange Market Efficiency' " by John Kitchen; (9) "Fiscal Policy, Exchange Rates, and World Debt Problems" by Douglas D. Purvis; (10) "Comments on 'Fiscal Policy, Exchange Rates, and World Debt Problems' " by Steven Kyle.

A "soft" landing requires that this be the result of voluntary action, such as a pro-savings tax policy or a reduction in the U.S. budget deficit accompanied by some fiscal stimulus elsewhere. A "hard" landing, in familiar form, occurs when overseas investors stop financing the current account deficit. Lower investment in the United States (or disinvestment) produces an involuntary rise in savings, along with a plummeting dollar, very high real interest rates, and a deep recession.

Steven Kyle adds some interesting addenda in commenting on the paper by Purvis. He believes that, so far as some fiscal adjustment is forthcoming, that farm subsidy programs will be among the first targets. However, the overall effect of these subsidy reductions depends largely on whether or not there is a soft or hard landing. A soft landing provides the opportunity for a devaluation. This raises exports, offsetting the decline in subsidies. A hard landing, however, could result not only in much higher interest rates, but in a contraction in world trade as well. Both would exacerbate the decline in farm income resulting from lowering subsidies.

There is not a great deal about agriculture in this book. However, so much of macroeconomics, especially areas which purport to explain exchange rate behavior, is such a mystery that cause and effect relationships between macroeconomic "shocks" and microeconomic results remain tenuous. Let us consider, for example, what is known about the effects of fiscal policy on exchange rate behavior. A fiscal expan-

sion may lead to either a currency appreciation or depreciation. A fiscal expansion may have either a positive or negative effect on agricultural exports.

Thomas Grennes and the International Agricultural Trade Research Consortium deserve thanks for an excellent reference to a complex and still poorly understood area in international economics research. This book contains a wealth of material that is very accessible to those who are not specialists in macroeconomics.

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Something for Everyone

1988 World Food Conference: Proceedings. *Edited by John W. Helmuth and Stanley R. Johnson. Ames: University of Iowa Press, 1989, 2 volumes, 589 pages, $34.95 each volume (hardcover).*

Reviewed by Carl C. Mabbs-Zeno

The fourth World Food Conference brought together many of the best known researchers on international agricultural economics to consider the problems of food production and distribution. In contrast to the first two conferences in this series, held in 1974 and 1976, the theme this time reflected a consensus that global food production capacity was more than keeping pace with needs, even while hunger was increasing. In following this theme, most papers placed responsibility for problems in human organization, interpreted as government policy, rather than in resource endowment.

These proceedings are organized into two volumes, one on policy (fewer than 100 pages) and the other on issues. The initial policy statements by eminent political figures in agriculture undergird the emphasis on policy in the subsequent issues papers. The papers are brief, and most are focused and written well enough to stand alone in making a useful point. Together the set of papers provides an encyclopedia of the dominant views on global agriculture, written by some of their principal proponents. Like an encyclopedia, controversy is minimized by moving quickly to new topics, although that tendency is partially offset by publishing reactions from conference participants at the end of each group of 2-5 papers.

Following the diverse discussions by politicians that open the first volume, the issues section ranges from ethical reflections to implications of specific policy reforms to policy recommendations. Enhanced food security is probably the central goal underlying most of the presentations.

Among the common strands woven into many of the papers is the debate over importance of encouraging exports to enhance national economic development. Since all the authors are knowledgeable about the progress of this debate, they are aware that exports are increasingly seen as critical to growth and development. Several cite the World Bank's 1986 *World Development Report* as the document that finally establishes the link between trade and development. The agreement of these authors with the World Bank may demonstrate where the mainstream lies, but it does not end the debate, and a few papers prepare us for the generation of problems that will follow from widespread application of free trade.

The contribution by M. Peter McPherson, who was administrator of the U.S. Agency for International Development during 1981-87 and a deputy secretary of the U.S. Treasury at the time of the conference, supports export orientation. Even though his article is more measured than some of his statements elsewhere, it contains signs of his glee at the emerging international policy consensus. Both McPherson and Secretary of Agriculture Clayton Yeutter (the other U.S. Government official represented in this volume and the former U.S. Trade Representative) are confident that the science of economics stands firmly behind their trade liberalization policies. Unfortunately for politicians, economics rarely embraces any policy without reservation.

The conventional alternative to export orientation, self-sufficiency, is treated sympathetically in a paper jointly authored by two officials of the Ministry of Agriculture in Indonesia and an official from Agriculture Canada. They separate different policies directed at self-sufficiency from the goal itself, and find that government investment in agriculture has an enviable record in assisting development. They join the consensus in decrying import restrictions, but laud self-sufficiency as an effective political and economic policy direction for developing nations.

Alex McCalla, chair of the Technical Advisory Committee, Consultative Group on International Agricultural Research and a professor at the University of California at Davis, brings a nongovernmental viewpoint to the debate. His view is refreshing in its willingness to accept a complex and conditional answer to a question phrased in global dimensions. His analysis of marginal returns to increasing levels of self-sufficiency relies on the most fundamental economic traditions of seeking a policy balance within the available options. He is conditioned to avoid seeking a free lunch and, instead, shows us what tradeoffs are necessary in each of several types of developing economies.

This collection's summary statements on policy and issues belong in the university classroom. The most interesting papers for most researchers are likely those covering topics outside personal specialties because, with such brief treatment of any particular subject, there is little news for the specialist. By avoiding the most transitory issues, however, the volumes achieve a timelessness that is essential for pro-

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ceedings released well over a year after the conference. For a society geared to news bytes, these proceedings cover international food policy in a familiar format. Even if each paper is actually more than a byte, the volumes basically offer light, but occasionally provocative, reading, much of which will appeal to agricultural economists from all branches and levels of the profession.

Rousing the Somnolent Beast

Soviet Agriculture: Comparative Perspectives. *Edited by Kenneth R. Gray. Ames: Iowa State University Press (A special study of the Kennan Institute for Advanced Russian Studies, Woodrow Wilson International Center for Scholars, Washington DC), 1990, 291 pages, $34.95.*

Reviewed by Elizabeth Clayton

By all accounts, Soviet agriculture suffers from all the bureaucratic ills: a petty management, a lazy (or alienated) labor force, wasted investment, and irrational prices. Any simple bystander/farmer with a modicum of power and know-how could improve things. Reforming this behemoth, which has proved difficult, is the subject of Gray's book. It should interest not only Soviet and socialist specialists in agriculture but anyone who has tackled a monolithic organization.

At the beginning and more visionary stage of a reform, which is Gray's focus, the reformers can suffer from a myopia that prevents a safe passage through untamed dreams and what is possible. Gray and his authors harness the would-be reformers by comparing the Soviet Union's agriculture to that of other socialist countries, to practice in the United States, and to statistical projections. The method has its flaws—noncomparable data, crude bases, infelicities of definition—but it is more serviceable than most methods and more easily understood. The data end in 1986, but the conclusions will still interest the 1990's reader.

Implicit in the comparative method is the attractiveness of foreign technology and practice and the possibility of borrowing it. The sources studied in this book are interesting: Jacobs finds that Soviet practice usually *precedes* the leading agricultural economics journal's report on a foreign practice. Personal contact would seem to be the key to its acceptance. Wyzan highlights Soviet borrowing from Bulgaria, especially by the large agro-industrial complexes. (He also points out that Bulgaria and the Soviet Union gave the same name to the organizations but created different concepts.) Nove highlights what the Soviets might learn about agricultural organization from the Hungarians.

Sources of borrowing are many, and the ultimate obstacle to agricultural development has a domestic origin. Often the knowledge is there. Craumer offers a precise, careful, and exceptional chronicle of dryland farming practices in the Soviet Virgin Lands (in the Russian and Kazakh republics), demonstrating Soviet ability to learn from experience, the need for regional adaptation, and the drive to learn and apply knowledge. The obstacle is implementation. Litvin addresses these obstacles by documenting the creation of agricultural information in scientific institutes but cites the nearly insurmountable barriers to transferring knowledge to production. Waedekin explores equipment shortages in small-scale (private) agriculture that keep if from attaining optimal output. Most of the failure is attributed to input suppliers, whose share of the agro-industrial sector's resources, according to Dovring's work, is unusually large and often wasted.

The one inflexibility of Soviet agriculture that overwhelms all others is irrational (disequilibrium) pricing. Prices are set, for example, to regulate peasant income, to extract land rent, and to support local government. Karen Brooks writes that establishing marginal cost pricing and allowing farmers to respond would increase output but would considerably change

The papers include: Section I—The Organization and Performance of Soviet Agriculture: (1) "Introduction" by Kenneth R. Gray; (2) "A Comparative Analysis of Agricultural Productivity Trends in Centrally Planned Economies" by Lung-Fai Wong and Vernon Ruttan; (3) "Costs of Agricultural Growth and Development: A Cross-National Analysis Focusing on the USSR" by Folke Dovring; (4) "Soviet Food Imbalances and Their Prospective Amelioration" by Ihor Stebelsky; (5) "Soviet Utilization of Food: Focus on Meat and Dairy Processing" by Kenneth R. Gray; (6) "Soviet Agricultural Policy and Pricing under Gorbachev" by Karen M. Brooks; (7) "Toward a Soviet Responsibility System? Recent Developments in the Agricultural Collective Contract" by Don Van Atta; (8) "Recent Changes in Soviet Rural Housing Policy" by Carol Nechemias; (9) "Trends in Soviet Dryland Farming and Soil Conservation Practices with Comparison to North American Developments" by Peter R. Craumer.

Section II—Borrowing from Foreign Agricultural Systems: (10) "Scientific and Technical Information Concerning Agriculture in the USSR" by Valentin Litvin; (11) "A Content Analysis of Writings on Foreign Agricultural Experience" by Everett M. Jacobs; (12) "The Bulgarian Experience with Centrally Planned Agriculture: Lessons for Soviet Reformers?" by Michael L. Wyzan; (13) "Private Agriculture in Socialist Countries: Implications for the USSR" by Karl-Eugen Waedekin; (14) "Can the USSR Learn from Hungarian and Chinese Agricultural Experiences?" by Alec Nove.

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the relative profitability of different crops, the traditional cropping patterns in some areas, and the distribution of income. Since other agricultural systems, such as the European Community and the United States, can thrive on disequilibrium prices, there are other factors at work. Gray rightly notes the Soviet predilection for public jealousy of "rich" farmers and the sensitivity (even outrage) toward speculation and monopolistic profits in processing and distributing. The managerial climate is not benign.

Reforms in the Soviet agricultural labor force show inconsistent results. On one hand, Van Atta, comparing the labor contracts between large farms and small work units in China and the Soviet Union, finds that Soviet productivity gains are inhibited because the Soviet small units obtain very little appropriate small-scale equipment, face public envy unheard of in China, and do not provide social welfare amenities. On the other hand, Wong's work indicates that labor productivity has risen and that technology, which has experienced a "negative growth," is the barrier to overall gains. (Wong's concept of negative technological change is engaging. It cannot be conclusive because he estimates a production function with physical data, not costs, and technology is a residual.)

Soviet labor incentives do have a social dimension. While farm incomes have risen along with agricultural subsidies, the increases have no value without an improved quality of life. Nechemias, investigating Soviet rural housing, finds that highly politicized programs have debased the value of investment. Furthermore, not all Soviet regions are identical. Stebelsky compares regional food supplies to consumption norms, which are rather like minimum daily requirements, and to international experience, and finds that Estonia comes close to an optimum, while Kirghizia experiences significant shortfalls. Waedekin's careful study of provisioning from the private plots finds that republics differ considerably in their attitudes toward private production and free markets.

This collection is highly informative and readable, has useful bibliographies and an index, and shows agricultural economics study at its careful best.

Agricultural Policy Reform: Politics and Process in the EC and USA. *Edited by H. Wayne Moyer and Timothy E. Josling. Ames: Iowa State University Press, 1990, 221 pages, $27.95.*

Reviewed by David Kelch

The authors of *Agricultural Policy Reform* unveil, for professional and layman alike, the layered and complex political process of agricultural policymaking in the pluralistic democratic societies of the United States and the European Community. Not content to stop there, the authors relate these political processes (and their implications) to the current Uruguay Round negotiations as well as to the GATT in general. No other book analyzes and compares the policymaking process in the United States and the EC *and* relates these processes to the GATT. It could not have come at a better time.

The four main parts of the book consist of the analytical framework, agricultural reform in the EC, agricultural reform in the United States, and international aspects of agricultural trade policy reform. Each of the four main parts of the book can be read independently, as can some of the nine chapters that make up the book, which considerably broadens its appeal. For example, readers uninterested in methodology can proceed to another section, while scholars can enjoy a critical examination of methodological choices.

The authors present the material in a very straightforward and readable style that allows the story to unfold with methodology enhancing the telling of it. The adoption of the public choice paradigm as their analytical instrument provides both analytical structure and intellectual legitimacy. Compared with other methodological choices, the public choice paradigm is appropriate in this study because it allows the authors to analyze the decisionmaking process when the decisionmaker is faced with simultaneous, multiple problems.

The breadth and depth of the coverage of the EC and the United States is exemplary despite limited space. The charts and figures are very useful for both casual readers and professional analysts. The analytical treatment of the U.S. legislative process and the role of the executive branch in using the public choice paradigm is of practical use to all readers because it clearly outlines the institutional forces that must be accommodated and provides the economic and political background to the policy process. The treatment of the EC policymaking process is the most concise and useful available to date. Invaluable insights reveal the complicated consensus-building required to make agricultural policy "common" in the EC. An excellent bibliography and useful footnotes are conveniently placed at the end of the chapters.

The incorporation of interview information leaves the reader with the impression of getting the inside story in addition to analyses based on theory. While the information derived from interviews is part of the raw material to be processed by the application of the public choice paradigm, the interviews clearly allowed the authors to arrive at conclusions that a purely technical analysis based on theory would not have permitted. The complementary nature of information derived from interviews and analysis based on public choice theory provides a compelling logical explanation to the policy processes when integrated by authors as knowledgeable as these.

The principle that the authors rely upon to explain the slow and incremental nature of agricultural policy reform in both the United States and the EC is partisan mutual adjustment developed by Charles E. Lindblom in the 1950's. This approach most frequently examines the actions of groups interacting to limit potential damage from the threat of reform. Partisan mutual adjustment also helps explain the importance of legitimacy over efficiency in political decisionmaking and assesses why rapid change can occur only when a serious crisis impinges on the process. Even so, the authors point to political timing and weather as variables which frequently dictate what can be done in agricultural policy. At other times it could be the force of individual personalities such as Andriessen in the EC, who succeeded a more passive EC farm commissioner, or Yeutter in the United States, who may yet reform both EC and U.S. farm policy.

An important point made in *Agricultural Policy Reform* is that outsiders find the agricultural political process incomprehensible and are effectively excluded as participants. More important, the authors say the political and economic complexity surrounding the shaping of the policymaking processes in the EC and the United States has increased the uncertainty of proposed reforms, created large bureaucracies that favor the *status quo*, and required an enormous amount of will and resources to effect change. The result is compartmentalization of the policymaking process which fosters parochialism in both the EC and the United States.

Chapter nine, which compares the United States and the EC, is particularly useful for analysts who wish to

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understand some of the fundamental historical, political, and economic differences between the two players. A good example of these differences according to the authors, and one which significantly complicates the Uruguay Round, is that small farms in the United States have relatively good soil compared with large farms while the converse holds in the EC. The goal of both U.S. and EC policies is to maintain family farm income and family farms. The EC thus faces a more difficult task because its family farms have poorer soil and are considerably smaller than those in the United States. (U.S. farms are, on average, 13 times larger than EC farms.) This helps explain why the EC is reluctant to let the market determine farm income.

The authors conclude that budget pressures are the most forceful for agricultural policy reform in both the EC and the United States, not the heat of congressional debate nor the noisy public protests by farmers. The authors argue that one of the principal reasons that agricultural policy reform is so slow is that the budget process and the agricultural policy process have not been sufficiently integrated.

Some may challenge the authors' conclusions, such as the role of USDA's Economic Research Service as a partisan in the 1981 and 1985 farm bill processes and the contributions of former Assistant Secretaries Lesher and Thompson to the 1985 farm bill. The list of the 24 interviewees in the United States and the EC is published in the Acknowledgments section, and a reader familiar with U.S. agricultural policymaking might be able to attribute some of the passages in the book to certain individuals.

The only disappointing section is in "Lessons for Policy-makers." The authors present a list of five reminders for agricultural policymakers that would be apparent to most interested observers, somewhat of a disappointment after so many important insights and useful conclusions. The authors and editors may have rushed to press in order to be timely. Other examples of a rush to deadline include identifying former U.S. Secretary of Agriculture John Block as William Block (p. 154) and some spelling errors and editing laxity. A particularly egregious example occurs on p. 148 when the struggle for originality when facing the mundane (a production increase) results in a flabby "engendered greatly enhanced domestic production." However, the authors can be easily forgiven these minor shortcomings of their collaborative effort because of the timeliness of the topic, the expertise they bring to the subject matter, and their capacity to enlighten the reader while making the topic accessible to a broad audience.

Agricultural Policy Reform is required reading for anyone interested in EC or U.S. agricultural policy, how and why agricultural policies are made, and how the processes behind EC and U.S. policies intersect in the GATT. Only the collaborative efforts of an experienced political scientist and agricultural economist could have given us a comprehensive and insightful analysis of such a complex topic. It will serve as a reference throughout what is likely to be a turbulent decade in agricultural policy reform around the globe and will be a valuable source in future works by policy analysts, academics, and even policymakers.

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